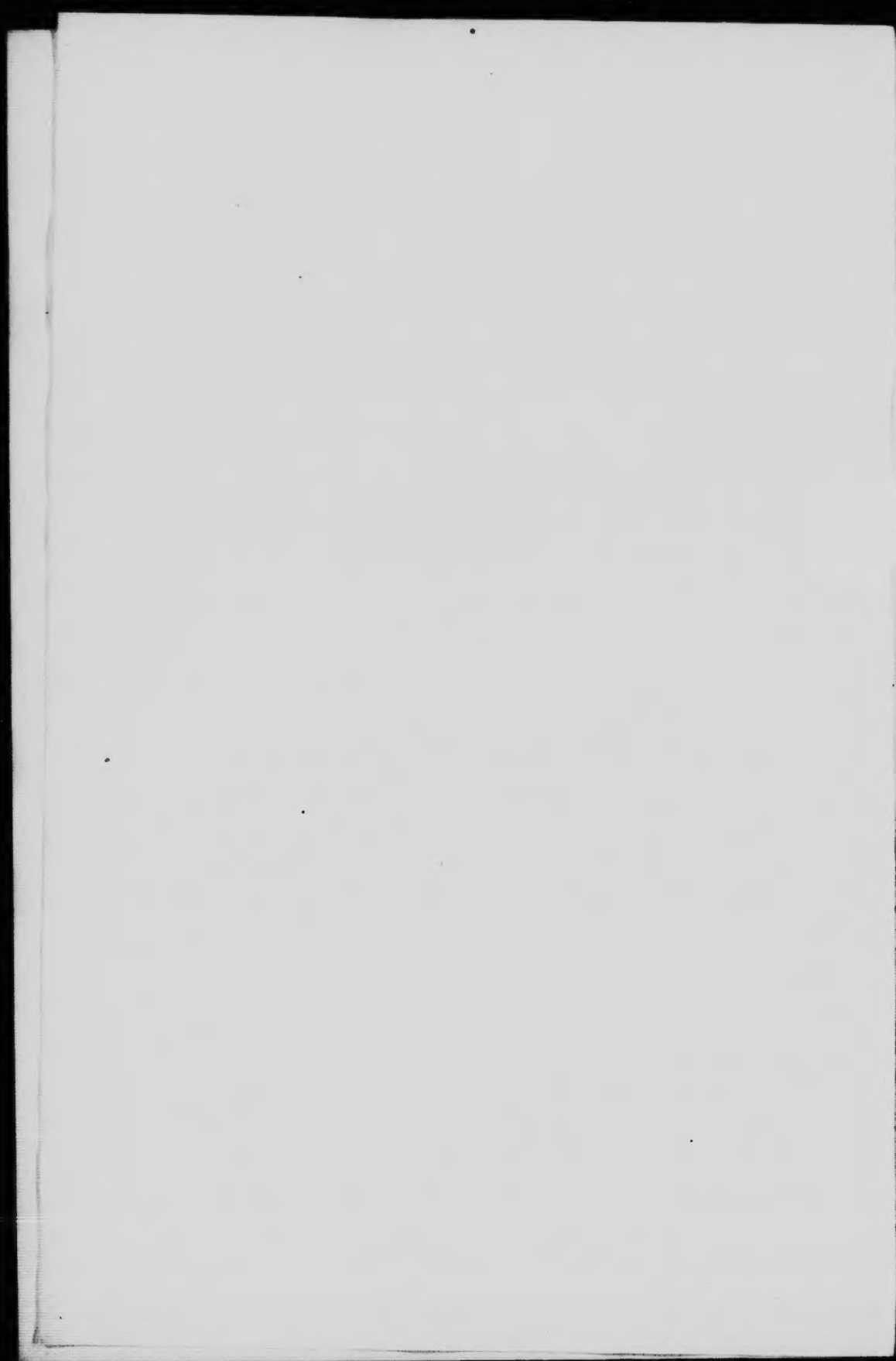




INGUINAL HERNIA

THE IMPERFECTLY DESCENDED
TESTICLE AND VARICOCELE

BY

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WITH 22 ILLUSTRATIONS

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PREFACE

THE following pages are largely founded upon a series of papers and lectures, some of which have been published in the *Proceedings of the Royal Society of Medicine* and various Medical Journals. They make no pretence to be a complete treatise on the subjects of which they treat, but are intended primarily to describe certain operations which I have employed for some time past and which I believe to have advantages over those commonly employed. Numerous excellent operations and other methods of treatment which are fully described in text-books and special works on these subjects are only briefly alluded to, or indeed may not be mentioned at all. This must not be taken to mean that their value is not recognised, or that they are not the most desirable methods of treating certain groups of cases.

Anatomical, pathological, and developmental facts and theories are considered only in so far as they have a practical bearing upon the operative treatment.

I have to thank the Director-General of the Army Medical Service for allowing me to make use of three papers written while I was serving abroad with the R.A.M.C., and for permission to publish the statistics given in Chapter III.

Many of the operations were performed at a general hospital in France, and I have to thank Lt.-Col. S. H. Fairrie, R.A.M.C., who was at that time in command of the hospital, and the medical officers for their co-operation and assistance.

I am also indebted to many books and papers on these subjects which I hope are fully acknowledged in the lists of references.

PHILIP TURNER.

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INGUINAL HERNIA.

CHAPTER I.

SOME ANATOMICAL AND PATHOLOGICAL CONSIDERATIONS.

DURING the past twenty years or so ideas as to the etiology and treatment of inguinal hernia have undergone a great change. This is chiefly due to the influence of the writings of Mr. Hamilton Russell, of Melbourne, who, in 1899, published a paper * in which he made the suggestion that in all cases of inguinal hernia, both in children and adults, the sac was a congenital structure and that it was always derived from a persistent patent funicular process. This theory, generally known as the Saccular Theory of Hernia, was subsequently elaborated by Mr. Russell in a series of papers,† and in these a congenital origin was also claimed for the sacs of femoral, umbilical and direct inguinal herniæ, as well as the ordinary indirect form of the latter. This led to considerable controversy, especially as to the etiology of femoral hernial sacs, but as it is proposed to discuss in these pages only the common indirect variety of inguinal hernia there is no need to go into this matter here. Those who wish to further consider the facts and arguments in favour of Mr. Hamilton Russell's views will find them ably and forcibly stated in the papers already mentioned, and also in the works of Mr. R. W. Murray, of Liverpool,‡ who is a strong supporter of

* R. Hamilton Russell, "The Etiology and Treatment of Inguinal Hernia in the Young," *Lancet*, 1899, Vol. II., p. 1353.

† R. Hamilton Russell, "Operation *e. Truss* in the Treatment of Inguinal Hernia in Childhood," *Lancet*, 1900, Vol. II., p. 1128; "The Congenital Factor in Hernia," *Lancet*, 1902, Vol. I., p. 1519; "The Congenital Origin of Hernia," *Lancet*, 1904, Vol. I., p. 707; "The Pathology and Treatment of Hernia in Children," *Lancet*, 1905, Vol. I., p. 7.

‡ R. W. Murray, "Observations upon the Etiology of Oblique Inguinal Hernia," *Lancet*, 1906, Vol. I., p. 363; "Note on the Etiology of Inguinal and Femoral Hernia," *Lancet*, 1907, Vol. I., p. 228; "Hernia, its Cause and Treatment" (Messrs. J. and A. Churchill), 1908.

the Saccular Theory. It is only necessary to state that, without altogether denying the possibility of a true acquired hernia, especially a direct hernia, in middle-aged and elderly men, I consider that the congenital origin of the sac in the vast majority of inguinal herniæ has been conclusively proved, and that this view of the etiology must be the foundation and starting-point of a discussion on treatment.

Before the days of the saccular theory, inguinal herniæ were divided into congenital and acquired. In the former, occurring almost entirely in infants and children, it was fully realised that the sac was a congenital structure, and that it was derived from an unobliterated funicular process; in the latter, which generally appeared during adult life, the hernia was regarded as due to the forcible tearing open of a weak part of the abdominal wall, and the protrusion, both of the peritoneal sac and abdominal contents, as the result of some sudden or long-continued strain. Acquired hernia was considered to be of much more frequent occurrence than congenital, and the following quotation from Holmes' "Principles and Practice of Surgery," a standard work of thirty years ago, gives a good idea of the old view of the origin of the acquired variety. "The non-congenital, or acquired, herniæ occur in consequence of a weakness of the abdominal wall at the seat of protrusion, and possibly also in consequence of an elongated state of the mesenteries of the viscera. The pressure of the viscera gradually pushes the peritoneum through the wall of the abdomen, and as it advances it contracts adhesions to the parts covering it; and when it has emerged from the cavity of the abdomen it swells out into a pear-shaped tumour, the constricted part communicating with the general cavity, being its neck; the dilated part, the fundus."

According to the saccular theory the sequence of events is totally different. At whatever age the hernia first appears the protrusion of viscera does not force out a peritoneal pouch before it, but the hernial sac is already present, and has been in existence since infancy owing to failure of obliteration of the funicular process. The effect of the sudden or long-continued muscular strain is merely to force out some intra-abdominal structure into this pre-formed and already existing sac. There is no primary

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weak spot in the abdominal wall, and if no hernial sac is present the strain alone will not lead to the formation of a hernia. The old view of the nature of an acquired hernia is epitomised in the popular term "Rupture," while, according to the saccular theory, this is a complete misnomer.

The view that all hernial sacs have a congenital origin allows, however, that when the protrusion of abdominal contents has taken place, the continuation of the strain in the absence of effective treatment may lead to an increase in size both of the hernia and the sac. It also allows that the existence of a hernia will in time, owing to the mechanical effect of the unnatural distension of the inguinal canal, produce a secondary weakness in the aponeurotic and muscular structures which enter into its formation. Such weakness is, however, not the cause of the hernia, but the effect. This secondary or acquired weakness of the muscular structures may be, as will be pointed out later, a most important factor in the recurrence of a hernia after operation.

Since the first appearance of a hernia during adult life is such a frequent occurrence, it must follow, assuming the saccular theory to be true, that many apparently normal persons must possess "potential herniæ"; that is, one, or possibly more, congenital sacs which are empty, but which are liable to have a piece of omentum or coil of intestine forced into them during some abnormal or unusual strain. That this is so has been definitely proved by pathological evidence. Thus Mr. Murray has published the results of two series of post-mortem examinations where there had been no history or evidence of hernia during life, and death had taken place from some other cause. In one series of 100 cases,* a sac was found in twenty-one, while in several there were two or more sacs. In the other series, of 200 cases,† sixty-eight peritoneal diverticula were found, of which fifty-two were femoral and thirteen inguinal. Mr. Hamilton Russell also recorded a case in which, though there was no evidence of hernia during life, there was found, after death, a peritoneal sac occupying the position of the sac of a direct

* *Lancet*, 1906, Vol. I., p. 363.

† *Lancet*, 1907, Vol. I., p. 228.

inguinal hernia.* He regarded the presence of these adventitious sacs as strong evidence for the saccular theory as regards these forms of hernia. Inguinal hernia is often bilateral, and it is by no means uncommon for a patient who has been operated upon for a hernia to apply later on for treatment of a hernia which has subsequently appeared on the opposite side.

Some surgeons have advised that, when operating for hernia, the inguinal canal of the apparently sound side should also be explored for the presence of a potential hernial sac. Thus Mr. E. W. Roughton,† in eighteen operations for unilateral hernia, found a potential sac on the opposite side in ten cases. The frequency of the double sac does not, however, seem to be sufficiently great to warrant this as a routine measure. I once found a potential sac under the following circumstances: A patient was admitted with a right inguinal hernia, but, inadvertently, the house surgeon had written up a diagnosis of left inguinal hernia. At the operation, the left inguinal canal was opened, and a sac of fair size was removed. The following day the patient complained that the wrong side had been operated upon, and, on coughing, the typical swelling made its appearance in the right inguinal canal. A few days later, another anaesthetic was given, and a very similar sac was removed from the right side.

The actual appearance of the hernia will depend upon a sudden or unaccustomed strain forcing some structure which should normally occupy the abdominal cavity into the pre-existing sac. Thus one would expect a considerable number of hernias to develop if a large body of men were taken from their ordinary occupations, especially if these were of a sedentary nature, and put to new duties calling for severe muscular exertion. This is exactly what occurred among the large numbers of men who were called from their civil occupations to military service. Large numbers of recruits developed hernias, either during the period of training at home or when sent for service abroad. In many, the hernia appeared to be an entirely new development, in others there was a history of a hernia during

* *Lancet*, 1904, Vol. I., p. 707.

† E. W. Roughton, "Bilateral Operation for Inguinal Hernia: its Advantages in Operating for Radical Cure in Young Adults," *Lancet*, 1912, Vol. I., p. 1534.

childhood or infancy, which was supposed to have been cured after wearing a truss; while, again, in others there was a history of the occasional appearance of a swelling which either was not present when they were passed for military service or was thought to be too trivial to require treatment. Though I operated on a large number of these cases, certainly several hundred, in many of which the hernia had only been present a few days or weeks, I never once found any bruising or other sign of traumatism. On the other hand, in a few the hernial sac was continuous with the tunica vaginalis, and in some others, a definite fibrous cord could be traced from the lower end of the sac along the spermatic cord to the upper part of the tunica vaginalis. The men were practically all strong and well-developed and otherwise healthy, and I strongly believe, in all these cases, that, though the hernia appeared to have been acquired, the sac was a congenital structure.

It will now be necessary to consider some points of the anatomy of the inguinal canal which explain how it is that this is not such a weak spot in the abdominal wall as at first appears to be the case. The inguinal canal is an oblique intermuscular space, about $1\frac{1}{2}$ inches in length, extending from the internal abdominal ring, which is situated about a finger's breadth above the centre of Poupart's ligament, to the external abdominal ring, situated just above the crest and spine of the pubis. The two rings are not opposite one another, so that the whole canal has a valvular arrangement. The canal is, of course, only a potential space, for it is normally entirely occupied by the spermatic cord. The vas and the other constituents of the cord, which, within the abdomen, are found in the extraperitoneal tissue, pierce, and gain a fascial sheath from, the transversalis fascia at the internal abdominal ring, which is situated immediately beneath the lower, free, arched border of the transversalis muscle. The internal oblique extends lower down than the transversalis, and, at first, is in front of the cord, thus forming part of the anterior or superficial wall of the canal. Its lower fibres, much more strongly arched than those of the transversalis, after crossing in front of the cord and supplying a covering of cremasteric fascia, turn downwards behind it to join the conjoined tendon

which forms part of the posterior wall of the canal. The aponeurosis of the external oblique completes the anterior wall of the canal, and the spermatic cord emerges at the external abdominal ring, deriving a covering from the intercolumnar fascia which stretches between the two pillars. Thus the canal is bounded by two muscular structures, the internal oblique and the aponeurosis of the external oblique, while the transversalis also enters into its formation in that it arches above the internal abdominal ring, and also takes an important part in the formation of the conjoined tendon. We have now to consider the action of these structures, and the part each takes in strengthening the inguinal canal. As regards the internal oblique, I cannot do better than quote Mr. Hamilton Russell's words * :—

“ The inguinal canal has this curious peculiarity, that it is formed by a rigid tendinous half and an actively contracting muscular half, and this anatomical arrangement in itself serves to invest the inguinal canal with an interest of its own ; it is, so far as I am able to recall, anatomically unique—it certainly holds a unique position among the various seats of hernia, and must, therefore, be placed in a special category, and be accorded a study and examination proper to itself alone. Now when curved muscle fibres contract they straighten, and the effect of the straightening of these curved fibres is to cause them to descend towards a position parallel to the floor of the canal and so to close the opening. In other words, the action of the curved fibres is sphincteric, and the inguinal canal is a half sphincter and is closed, so far as the structures passing through it permit, by this sphincter action. I need not, of course, remind you that the region of the internal ring is covered in and further supported by a portion of the internal oblique as it springs from Poupart's ligament ; that the conjoined tendon fortifies the inner part of the canal, and that the whole region receives support from its covering of external oblique aponeurosis ; but the enormously preponderating factor in the prevention of hernia is the sphincter-like action of the arched fibres, which limit the canal above as they pass to their insertion into the conjoined tendon. The immediate cause of the production of hernia is,

* *Lancet*, 1899, Vol. II., p. 1353.

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in all cases, forcible compression of the abdominal contents, as in straining; and in the absence of such straining, there is no chance of the occurrence of hernia, for there is ample room in the quiescent abdomen for all the abdominal viscera, and a *vis-a-tergo* is required before any viscus can be forced out. Furthermore, in the normal condition of the inguinal canal, there is no opening, except such as is occupied and accurately filled by the spermatic cord; for the rest, the canal is a potential opening only, and does not become open until something is forced into it to make it so. Now, the compressing force which tends to the production of hernia we may, for practical purposes, regard as being invariably the contraction of the muscular system by which the abdominal contents are enclosed, but the contraction of the abdominal muscles involves also the contraction of the curved fibres which, we have seen, constitute what I have ventured to call the sphincter of the inguinal orifice."

We may add to the above description that the transversalis muscle probably has some similar action. The lower fibres of this muscle take origin from the outer third of Poupart's ligament, curve inwards just above the internal abdominal ring, and then downwards, where they are joined by the lower part of the internal oblique, with which they form the conjoined tendon, and gain insertion into the crest of the pubis. These curved fibres must also straighten when they contract, and must give a decided support to the inguinal canal as well as to the internal abdominal ring.

We have now to consider the part played by the aponeurosis of the external oblique. Two points are obviously of the greatest importance. The first is the presence of the external abdominal ring, and the second that the adjacent portion of the aponeurosis forms the most important insertion of the external oblique. This muscle, the fibres of which are directed downwards and inwards, arises from the lower eight ribs, and, though the posterior fibres have an insertion to the crest of the ilium, the greater part of the muscle ends in the aponeurosis, the only attachment of which to bone, at any rate below, is to the crest of the pubis and, through Poupart's ligament, to the pubic spine. The long axis of the muscle, and hence the line of most direct and

powerful action, extends from about the seventh rib above to this bony insertion below. The external abdominal ring,* which arches over the spermatic cord at its exit from the inguinal canal, is bounded externally by Poupart's ligament, known also as the outer pillar, or crus, and internally by that part of the aponeurosis attached to the pubic crest which is the internal pillar, or crus; it is thus intimately related to the two most important bony attachments, and must be regarded itself as part of the insertion of the external oblique. The ring is generally described as "somewhat triangular in shape," and as the base of the triangle is formed by the spine and the crest of the pubis, it is seen that it has firm and definite boundaries below, and to the inner and the outer side. It seems to me, however, that sufficient attention has not been directed to the upper boundary or apex of the ring. It is easy to satisfy oneself that the upper limit of the ring is not an angle formed by the meeting of the two pillars. All that is necessary is to examine a patient with a hernia, or, indeed, a normal individual, lying down on a couch, by invaginating the scrotum and sweeping the finger round the margin of the ring. Such an examination will show that above there is a definite rounded margin, and if the examination be repeated with the patient in the erect position it will be found that this margin is subject to very considerable tension. The ring is not an open gap, but is closed by the intercolumar fascia which stretches between the two pillars and gives a sheath to the spermatic cord where that structure becomes superficial. Above the ring scattered transverse bundles of fibres continue to connect the two pillars, and may sometimes be traced as high as the level of the anterior superior spine. If the upper margin of the ring be examined, as can easily be done at operations for hernia, it will be found that there is always a more or less complicated arrangement of fibres to strengthen this important spot. Figs. 1 and 2, drawn diagrammatically from actual rings, show a typical arrangement. It will be seen that, in addition to the intercolumar fibres, there are also strong decussating bands passing from the inner pillar to the lower end

* Philip Turner, "The External Abdominal Ring and its Importance in the Radical Cure of Inguinal Hernia," *Guy's Hospital Reports*, Vol. LI.

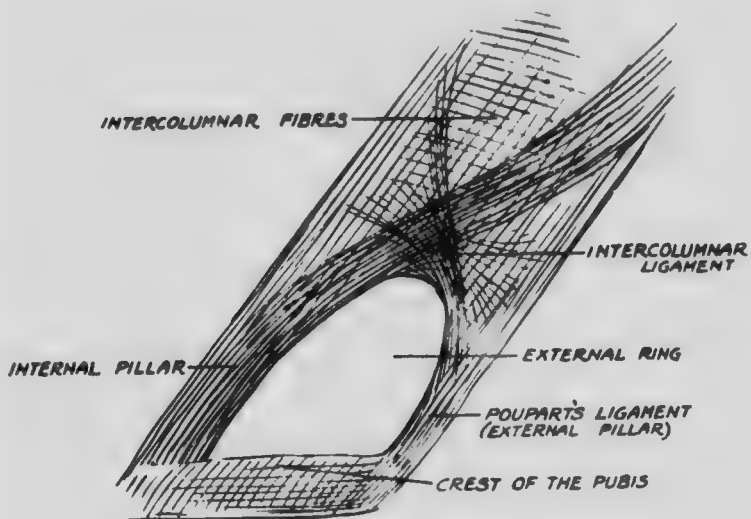


FIG. 1.

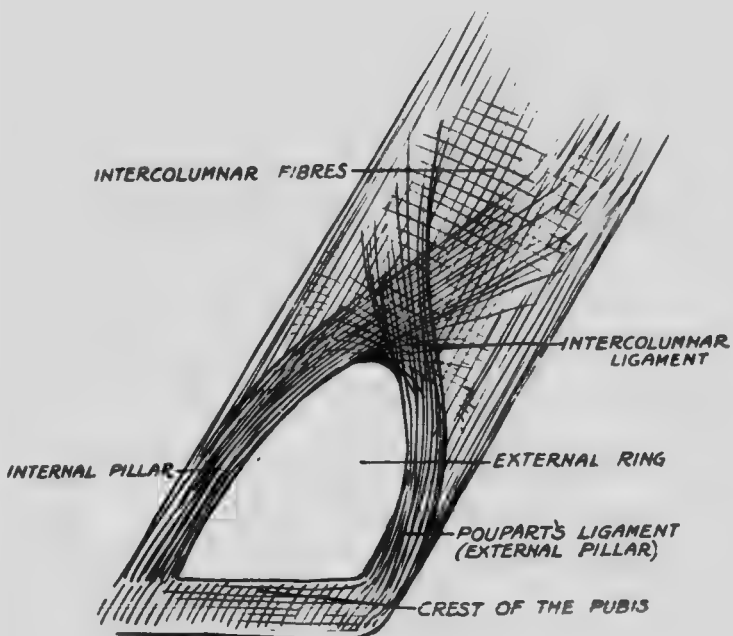


FIG. 2.

of Poupart's ligament, and also from the upper part of Poupart's ligament to the lower part of the internal pillar. These decussating fibres are always present, but their strength and mode of arrangement varies considerably. Occasionally they are symmetrical, but often one band will be well-developed and the other only slightly marked. In most cases they are of much greater importance in securing the strength of this part of the ring than the intercolumnar fibres, and they are also responsible for the rounded character of the upper margin of the ring. Indeed, their structure is so definite and their importance so great, that this upper boundary of the ring seems worthy of a definite name. "Intercolumnar Ligament" expresses both its relation and function, and as such I shall refer to it on any subsequent occasion. In an aponeurotic structure, the fibres are chiefly developed in the line of the greatest strain, and hence, in the aponeurosis of the external oblique, the general direction of the fibres is downwards and inwards. The appearance of the decussating fibres at the upper margin of the external ring can only mean that this is a spot where there is considerable tension, and that the function of the intercolumnar ligament is to strengthen what would otherwise be a weak spot. When the external oblique contracts the decussating fibres of the ligament must counteract any tendency to split up the aponeurosis from the upper margin of the ring, and, indeed, it would seem quite possible that the effect of muscular contraction acting upon them is to slightly approximate the upper parts of the pillars of the ring.

From the above considerations we may conclude that the strength of the inguinal canal depends upon the normal development and the free and unimpeded action of the muscular and aponeurotic structures which enter into its formation.

It will now be necessary to discuss the nature and the causes of the secondary weakness which, we have seen, may appear in the inguinal canal as the result of the presence of a hernia. We have seen that the healthy inguinal canal is only a potential space, being completely occupied by normal structures; but when a hernia is present this is no longer the case, for abnormal structures, the sac and its varying contents, also occupy the canal.

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When once the sac has become distended, the tendency is for the hernia to increase in size, and thus abnormal pressure, which may be continuous or intermittent, and is variable in amount, will be exercised on the structures which bound the inguinal canal. If the hernia appears during infancy or childhood, the normal development of the muscular and aponeurotic structures will be impeded; but if it develops during adult life, after the muscles have reached their full development, the tendency will be for these structures to undergo a greater or less degree of atrophy, thinning, or fibroid change. These changes are generally slow and gradual, but in old-standing cases they may become very marked. If the hernia is treated by operation at an early stage, before secondary changes have become marked, it is reasonable to hope, in younger patients who have not reached full muscular development, that, with the removal of the cause of the weakness, the muscles may recover their full strength and tone. In muscular young adults, too, provided that the hernia is treated at an early stage, before any marked secondary changes have occurred, it may be confidently expected that the muscles will regain their power and function when the source of weakness has been removed. When, however, we are dealing with patients of middle age or beyond, the possibility of the complete recovery of muscular power and tone becomes less likely, and, indeed, in old-standing hernias at these periods of life, the secondary changes are so great, and recovery of muscular power is so unlikely, that we must regard the inguinal canal as permanently and irretrievably weakened.

This acquired weakness affects all structures, both muscular and fascial, which take part in the structure of the canal. The internal abdominal ring, no longer a potential but an actual opening, is enlarged, and tends to increase downwards in the direction of least resistance. The lower part of the internal oblique, instead of closely encircling the spermatic cord, becomes stretched and thinned out by the pressure of the neck of the distended sac, and, in late stages, is merely a fascial structure in which run a number of lax muscle fibres. The conjoint tendon also undergoes a similar change; its outer edge becomes thin and atrophied, and the tendon is firm and resistant only to

the inner side, instead of forming a strong posterior wall to the lower part of the inguinal canal. The external ring also enlarges by gradual stretching of the intercolumnar ligament, so that there tends to be some separation of the pillars, and the aponeurosis itself becomes thinned and weakened. Thus, in cases where a hernia has been present for many years, especially if it is of large size, the valvular character of the canal may disappear, so that the enlarged external ring may be nearly opposite the greatly increased weak portion of the posterior wall. There may then be a direct gap in the muscular structures of the abdominal wall through which two, or even three, fingers can be introduced. Under these circumstances, when the most active period of adult life has passed, and the muscular system anywhere is more likely to degenerate than to improve, recovery of the normal strength and mechanism of the inguinal canal must be regarded as impossible; hence, owing to the secondary or acquired weakness, an operation for the cure of the hernia is liable to be followed by a recurrence. Simple removal of the sac alone is unlikely to be successful, and it would appear to be desirable to adopt, in addition, some method of strengthening the inguinal canal.

The presence of secondary weakness is naturally of great importance in the operative treatment of hernia, and the indications for treating it, as well as the methods to be adopted, will have to be further considered later on. Before operating upon a case of hernia it is always desirable to examine the affected side for the presence of any secondary weakness, and to gain some knowledge of its character and extent. This may be done by a digital examination of the external ring and the inguinal canal, the patient lying down upon a couch. The apparently sound side should also be examined, and the structures here compared with those on the side where a hernia is known to be present. The lower part of the scrotum is invaginated by the forefinger, which is passed upwards until the crest of the pubis is felt. The external ring will be felt immediately above the pubic crest. The size of the ring is then estimated by sweeping the finger round its margin, when the rounded upper border formed by the intercolumnar ligament is also noticed. The

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normal ring should just admit the tip of the forefinger. If the finger can be made to traverse it and enter the canal, the ring is certainly enlarged; if the tip of the finger be pressed backwards through the ring, the conjoined tendon will be felt; if the ring is slightly enlarged, the thin sharp edge of this structure will be felt; while, if the canal is seriously weakened, the finger can be easily made to impinge upon that part of the posterior wall formed by the transversalis fascia. As has already been pointed out, in very advanced cases it may be possible to introduce one or two fingers directly through the stretched-out canal and palpate the abdominal surface of the pubis. By this method of examination it will be possible, in most cases, to decide whether simple removal of the sac will suffice, or whether it will be desirable to adopt, in addition, some means to strengthen the abdominal wall. Sometimes, on thus examining a patient with a small hernia, or where the swelling has only recently appeared, considerable evidence of weakness in the muscular and aponeurotic structures may, nevertheless, be found. In such cases it may be argued that the weakness found cannot have appeared since the hernia was first noticed, and that it must be regarded as primary weakness.

Another, and a more probable explanation, can, however, be given. According to the saccular theory, the hernial sac has been present since infancy, and this abnormal structure, which has always occupied the inguinal canal, may have interfered with its normal development. It may be objected that this structure consists only of a thin peritoneal sac, and occupies so little space that it could scarcely give rise to any sufficient or undue pressure on surrounding structures. We have to remember, however, that with the delicate tissues of a developing child, a very slight degree of pressure, if continued over a long period, may have a very grave effect upon the development, not only of muscular, but also of bony structures. Besides which it is extremely probable that, though there may have been no actual hernia, the sac has contained a varying amount of peritoneal fluid, which, though not sufficient to cause any noticeable swelling, may, nevertheless, have been sufficient to have interfered with the normal development of the canal.

There are also two other causes of acquired weakness which are of great importance, for they have a very important bearing on the treatment of inguinal hernia.

Acquired weakness may be due to long-continued pressure by a truss. The effect of this pressure in children is to hinder the normal muscular development in the region pressed upon, and, in adults, to lead to atrophy of the muscle fibres. In advanced cases, both in children and adults, there may be found, on examination, a soft area in the abdominal wall in the region of the inguinal canal as the result of this pressure. Such muscular wasting is doubtless, in both children and healthy adults, capable of recovery; but, on the other hand, it may, especially in later life, have an adverse effect upon the result of an operation. This suggests certain practical rules which may be followed with advantage in the use of trusses.

In the first place, after the first year of life, there is no evidence that a truss really "cures" a hernia. The utmost it does is to keep the sac empty, and if the sac be kept in an undistended condition for some months or years the relation of the neck of the sac and the abdominal cavity may become so altered, probably in part owing to a relative diminution in size of the opening, and in part to the viscus which previously descended having become accustomed to some other part of the abdominal cavity, that an apparent "cure" may result. The sac, however, remains, and there is always a chance of the hernia reappearing later in life. It is no uncommon thing, when a hernia develops during adult life, to get a history of a hernia during childhood, which had been "cured" after wearing a truss. Thus, in children and young adults, a hernia should always be treated by operation, and a truss should only be employed under the following circumstances: (1) In infants, where it is thought that there is a possibility of the processus vaginalis closing if the filling of the sac is prevented by some form of soft india-rubber truss. If, however, the hernia is large, if it becomes irreducible, or if it is with difficulty controlled by the truss, operative treatment should be carried out, even in infancy, provided the general condition of the child is satisfactory. (2) In older patients, a truss may be employed as a temporary measure if the general

health, or some special circumstances, contra-indicate immediate operation. (3) A truss should, of course, be used if the patients or the parents refuse operation, or if there are any permanent contraindications to operative treatment. From what has been said above it will be seen that one of the chief safeguards against the recurrence of a hernia after a radical cure is that the muscular structures shall recover their power and tone. As a truss may hinder this, and as it may be a source of acquired weakness, it should not be used after operation in those cases where there is a reasonable prospect of the success of the operation. It must be remembered, however, in many of those cases where the acquired weakness is excessive, and especially where the hernia is of long-standing, or of large size, or only partly reducible, and the patient past the prime of life, that the object of the operation may be rather to enable the patient to wear a truss in comfort than to obtain a true radical cure of the hernia. Needless to say, in such cases the wearing of a well-fitting truss is part of the necessary after-treatment of the operation.

Injury to the structures bounding the inguinal canal may be a cause of acquired weakness, and, as such injury is only likely to occur during operation, and must have an important bearing upon the ultimate result, this matter is of great importance, and calls for careful consideration. That trauma applied to the abdominal muscles may result in the appearance of a hernia is well known, and such a result is occasionally seen after operations for appendicitis and other conditions, especially where pus is present and drainage is necessary, and where incisions are required in the lower part of the abdominal wall.

When a muscle is injured, whether by division or laceration of its fibres, repair takes place by the formation of fibrous tissue ; no new muscle fibres are developed. In order to avoid injury and consequent weakening of muscles in the exposure of deep structures during operations, the incision is always carried, if possible, between muscles, and, if this cannot be done, the muscle is split in the direction of its fibres. In the same way, when an aponeurotic structure is divided, it also should be split in the direction of its fibres. Otherwise there will be tension on the scar, and the newly-formed fibrous tissue will be liable to stretch.

These principles are illustrated by the methods in common use for opening the abdomen for the removal of the appendix. In the "gridiron" incision, the muscles are split in the direction of their fibres, and additional strength is gained by the fact that the fibres of the split muscles run in very different directions. In the incision through the rectus sheath the muscle is displaced, and, after the operation, the strength of the abdominal wall is ensured by the uninjured muscle intervening between the incisions in the anterior and posterior layers of its sheath. If a muscle is divided at its insertion, whether this is by muscular or tendinous fibres, subsequent stretching and weakening are particularly likely to ensue, since this is the point of maximum tension when the muscle contracts. In order to apply these principles to the operative treatment of inguinal hernia, it will be necessary first to consider the structure and anatomy of recurrent hernias and the causes of the failure of the operation. This subject scarcely seems to have received the attention which its importance merits, but Mr. Battle read a most interesting paper on this subject as long ago as 1908,* on which many of the following remarks are based. Recurrent hernias fall into the two following groups, of which the second is by far the more common. In the first, there is a sac of somewhat similar character to that of the original hernia. It follows the course of the spermatic cord, projecting from the external abdominal ring, or even extending down towards the scrotum, much as it did in the original hernia. In the second and more frequent group, there is chiefly a bulging forwards along the whole length of the inguinal canal. Further examination shows that there has been a splitting up of the aponeurosis of the external oblique from the external ring, which is elongated and enlarged, so that the intercolumnar ligament can scarcely be felt, or may have completely disappeared. In addition, the whole scar has stretched so that there is a general bulging forwards of all layers from the peritoneum to the skin. This condition can scarcely be regarded as a true recurrence of the original hernia, but is rather analogous to the post-operative ventral hernias which

* W. H. Battle, "Recurrence after the Operation for Radical Cure of Inguinal Hernia," *Lancet*, 1908, Vol. II., p. 1601.

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occasionally develop after laparotomy, and is due, doubtless, to the same cause, viz., injury to the abdominal wall in the region of the incision, leading to weakness and subsequent yielding of the scar.

A third variety of recurrence may be distinguished, which is simply a combination of the two already described. The explanation of the first form of recurrence is that at the operation the sac was not completely removed, so that a small pouch remained, allowing some abdominal structure still to pass into or through the internal abdominal ring. Mr. Battle also suggests, as explanations of this form of recurrence, that either, owing to laceration of the neck of the sac, the peritoneal cavity was not closed at the operation, or that, owing to straining, such as occurs in post-anæsthetic vomiting, the ligature may have been displaced. If these suppositions are true, the contents will escape through a rent in the peritoneum into the inguinal canal, and the recurrent sac will be of adventitious origin. The lesson to be learnt from this form of recurrence is that the sac must be completely removed, so that there is no pouch or depression of the peritoneum, and that the ligature must be securely tied after transfixion at a sufficiently high level.

If a recurrent hernia of the second type be operated upon, an examination of the parts will confirm the view that there is a giving of the scar, and that the hernia is essentially traumatic. Much scar tissue will be found, and the various muscular and aponeurotic structures are inseparably matted together. The scar tissue is very lax, and much of it will have to be excised before it is possible to bring the various layers of the abdominal wall together. The operation most commonly performed for inguinal hernia is Bassini's, or some modification of this. In this operation, in order to ensure complete removal of the sac, the inguinal canal is opened up by incising the external oblique aponeurosis from the external ring to where it covers over the internal ring. In doing this the decussating fibres of the inter-columnar ligament are divided. I have endeavoured to show the importance of this ligament, and also that it, as well as the lateral boundaries of the external ring, are an extremely important part of the insertion of the external oblique. It is true

that, after the removal of the sac, the aponeurosis is sutured and the ring reconstructed so that it is reduced to about the normal size. No suturing, however, can bring these fibres together so that they shall unite and form as strong a structure as the original ligament. The result is that when the external oblique begins to act the mechanism which draws the pillars of the ring together has been destroyed, and is represented only by some soft newly formed scar tissue at the upper border of the new and artificial external ring. It is easy to understand how, as the result of strain, the pillars of the ring may separate and the scar tissue repairing the incision in the external oblique may stretch, leading on eventually to the condition found in the second type of recurrent hernia.

An essential part of Bassini's operation is an attempt to strengthen the inguinal canal, based upon the assumption that weakness of this structure was the primary cause of the hernia. The method adopted is to suture the outer free border of the conjoined tendon to Poupart's ligament, thus increasing the area of the posterior wall formed by the former structure, and diminishing the size of the internal ring. Certainly, if, at the close of the operation, the posterior wall of the canal be examined with the finger, it feels much firmer and more resistant than it did before, but the amount of permanent good is open to doubt. There is a good deal of tension on the stitches, and it is probable that in many cases they quickly cut through. In any case, the conjoined tendon is mainly a muscular structure, and, as the result of the laceration and strangulation of its fibres by the sutures, the eventual addition to the posterior wall of the canal will be a thin layer of scar tissue which is liable to give and bulge when again subjected to strain. Now we have seen that the strength of the inguinal canal depends upon the normal and free action of the muscles which take part in its formation. Hence we may infer that, in children in whom the muscles have not reached their full development, and in adults with good muscular development and no marked secondary weakness, these attempts to strengthen the canal are not necessary, and that the laceration and interference with the functions of the muscles is more likely to be harmful than beneficial. The case is different in patients

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with hernia of long duration and great secondary weakness, and in older patients whose muscles are permanently stretched and weakened. Here one feels that there is no possibility of the muscles regaining their normal power and function. Owing to the lax and thinned-out conjoined tendon, the tension on the stitches will be less, and while it is unlikely that the additional injury will appreciably increase the muscular weakness already present, it is possible that benefit may accrue from the additional fibrous support to the posterior wall of the canal.

Mr. Battle, in the paper quoted above, discusses the causes of recurrence. Suppuration is commonly regarded as responsible for many cases of recurrence, but Mr. Battle found, in 107 cases of recurrent hernia which he collected, that there had been suppuration in only twenty-two. Undoubtedly the hernia reappears in some cases, which have become infected during operation, but in many recurrent hernias the wound healed by primary union at the original operation. Suppuration, injudicious after-treatment, post-anæsthetic bronchitis and vomiting may be contributory causes of failure, but the chief causes of recurrence of hernia after operation are: (1) Incomplete removal of the sac; (2) the existence of an advanced condition of secondary or acquired weakness, often in an elderly patient, or in one not particularly suitable for operation; (3) trauma, or faulty technique, during the operation.

It is generally agreed, if an operation for the radical cure of hernia is a failure, that the recurrence will appear within a few months of the operation. Mr. Battle found that as many as 85 per cent. of recurrences were noticed within twelve months. Coley * gives statistics to prove that patients very rarely get

* "The Results of 1,000 Operations for the Radical Cure of Inguinal and Femoral Hernia performed between 1891 and 1902," by W. B. Coley, M.D., *Annals of Surgery*, June, 1903. Dr. Coley writes: "In former papers I have stated that by far the greatest proportion of relapses occur within the first year after operation, and that most of them occur within the first six months. This opinion was based on an analysis of 365 cases of relapsed hernia observed in the out-door department of the Hospital for the Ruptured and Crippled, and operated upon by various methods. This series of cases showed that 85 per cent. of relapses occurred within the first year following the operation, and that 65 per cent. occurred within the first six months. I have recently made a study of 165 new cases of relapse observed since the previous statistics were completed. This series shows that in 26 cases the interval between operation and relapse was unknown, leaving 139 cases as a basis of calculation. It was found that 91, or 65 per cent., relapsed within the first six months, and 111, or 80 per cent., within the first year after operation."

recurrences after one year; over 90 per cent. of the relapses appear in the first twelve months after operation. This early development of the recurrence is what one would expect if incomplete removal of the sac and trauma are regarded as the chief causes. If it were due to the formation of a new sac and the gradual opening up of the inguinal canal in the way an "acquired" hernia was formerly supposed to develop, one would expect a much slower process, and the majority of recurrences might be expected to appear at a much later date than twelve months after the operation.

The practical bearings of the saccular theory, and the considerations which arise from it on the operative treatment of hernia, may be summed up as follows:

(1) The essential cause of inguinal hernia is the presence of the congenital sac. There is no primary weakness of the abdominal wall which causes the hernia to appear.

(2) Hence, to cure the hernia, it is essential to completely remove the sac. As there is no primary weakness, there is no need to attempt to strengthen the inguinal canal.

(3) The operation should be carried out as soon after the appearance of the hernia as possible, before the development of any secondary weakness.

(4) In cases where there is advanced and irrecoverable secondary weakness the sac should be completely removed and an attempt made to strengthen the inguinal canal.

(5) The operation should, in all cases, be carried out with the least possible damage to the structures entering into the formation of the inguinal canal.

(6) The external abdominal ring, since it is an important insertion of the external oblique, should not be divided, unless for some reason this is absolutely necessary for the satisfactory performance of the operation.

CHAPTER II.

THE OPERATIVE TREATMENT OF INGUINAL HERNIA.

THE operation which will be described in the following pages attempts to carry out the principles stated at the close of the last chapter. The operation in children and young adults, where there is little or no secondary weakness, will be first described, and, subsequently, a modification which enables the conjoined tendon to be sutured to Poupart's ligament, as in Bassini's operation, which is employed in older patients and those where well-marked secondary weakness is present. The principle of the method is that the sac is approached from above, immediately below the internal abdominal ring, instead of dividing the external ring, slitting up the external oblique, and opening up the inguinal canal, as is usually done. Generally speaking, this particular operation is applicable between the ages of four and thirty years, but each case must be treated on its merits. Especially important is the examination for the presence and extent of any secondary weakness in the manner which has already been described. In infants and young children the inguinal canal is so short, and the internal and external abdominal rings are so nearly opposite one another, that it is possible to satisfactorily remove the sac by freeing and isolating it after it has emerged from the external ring, and then drawing it down and ligaturing it as high as possible. In older children and adults the canal is longer, and if this procedure were adopted there would almost certainly be left a funnel-shaped projection of peritoneum through the internal ring which would probably lead to a recurrence of the hernia.

I first employed the method of completely removing the hernial sac through an incision through the external oblique in the region of the internal ring about eight years ago. At first, I operated in this way in children, but have since used it more and more in adults, until at the present time, except where

special indications point to the advisability of some other method. I use it, or a modification which will also be described, as a routine method in all cases. The credit of first suggesting the desirability of approaching the hernia in this way belongs, I believe, to Mr. G. L. Chiene, who, after I had read a paper on "The Radical Cure of Inguinal Hernia in Children" before the Royal Society of Medicine, Section for the Study of Disease in Children,* in 1912, drew my attention to a paper of his which I had not previously seen. In this paper† Mr. Chiene advocates ligature of the neck of the sac immediately below the internal ring without opening up the inguinal canal. He puts forward the three following principles: (1) That for practical surgical purposes all oblique inguinal hernias are primarily due to the presence of the congenital sac. (2) In young adults, the valvular action of the muscles guarding the internal abdominal ring will be regained if the cause of the dilatation of the canal be removed. (3) If the neck of the sac be efficiently dealt with, it is quite unnecessary to interfere with the remaining portion in the inguinal canal or the scrotum. While thoroughly in agreement with the first two of Mr. Chiene's propositions, I am quite unable to accept the third. To leave any part of the sac behind in the inguinal canal would only be to leave an abnormal and useless structure, which might become distended with fluid and, in any case, might interfere with the muscles regaining their normal action, or actually be the cause of increased secondary weakness. I can only repeat that I regard complete removal of the sac as the most essential part of the operation.

The Operation.

For convenience in description, it will be assumed that the patient is a young adult aged about twenty; that the hernia is on the right side; that the sac is not continuous with the tunica vaginalis, and that there is no appreciable secondary weakness. In a younger patient the operation will be similar, but the incisions will be shorter, and the structures involved will be

* Philip Turner, "The Radical Cure of Inguinal Hernia in Children," *Proc. Roy. Soc. Med.*, 1912, Vol. V., Section for Study of Disease in Children, p. 133.

† G. L. Chiene, "Preliminary Note on a Simple Operation for Uncomplicated Hernia in Young Adults," *Brit. Med. Journ.*, 1907, Vol. II., p. 1389.

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smaller and more delicate. The operation may be described in the following stages.

(1) *Preliminary Preparation.*—This will be on the usual lines, according to the practice of the surgeon. For the past five years I have always used a solution of 2 per cent. picric acid in methylated spirit for sterilising the patient's skin, and have found

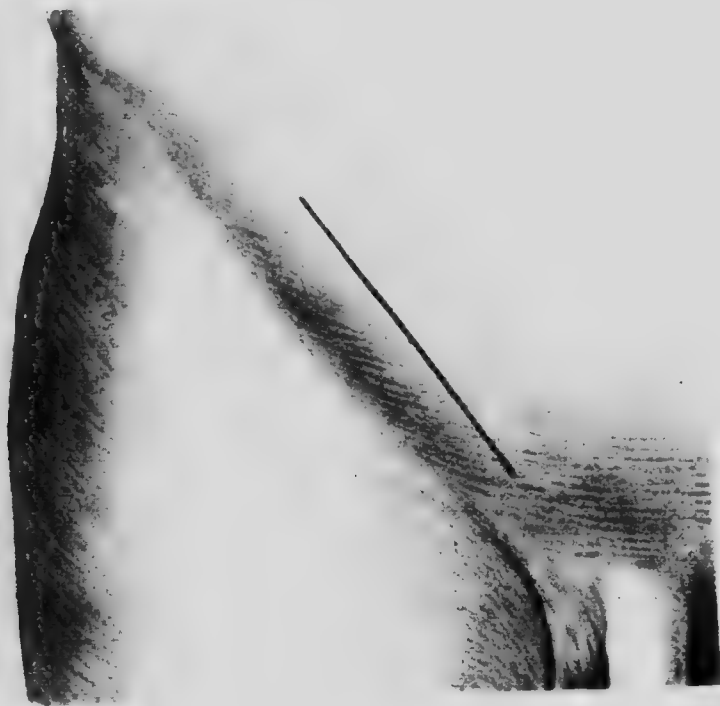


FIG. 3.

it perfectly satisfactory. One important advantage that it has over tincture of iodine is that it is less irritating to the sensitive skin of the scrotum. This is of special importance in children, who are apt to put their hands under the sterile pad after preparation by the iodine method and scratch to relieve the irritation.

(2) *The Skin Incision* (Fig. 3).—This is at a slightly higher level, and, hence, further from the groin than in Bassini's operation. The incision is about three inches in length, and runs

parallel to and slightly above Poupart's ligament, ending below, just above the spine of the pubis. Skin and fasciæ are cleanly divided down to the aponeurosis of the external oblique, care being taken not to incise the latter structure at this stage. When any divided vessels have been secured the superficial structures are dissected back, so as to give a good view of the aponeurosis and of Poupart's ligament. The external

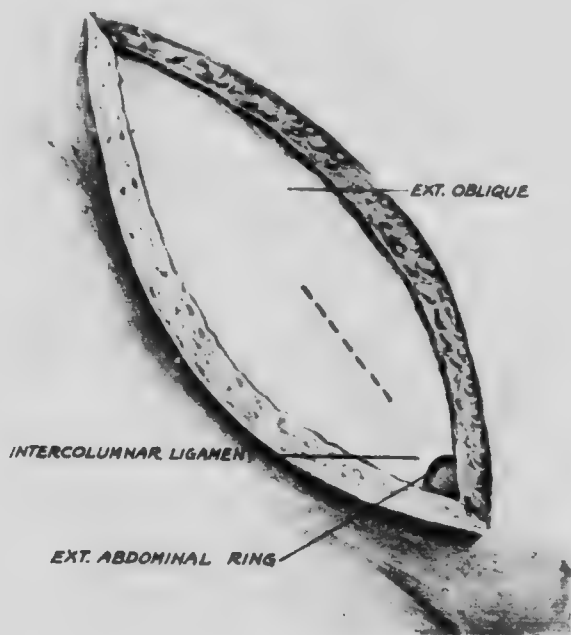


FIG. 4.

abdominal ring is not fully exposed, though its upper margin should be identified at the lower angle of the wound, and its size and general condition investigated by inspection and by digital examination.

(3) *Incising the External Oblique* (Fig. 4).—If the aponeurosis be examined the general direction of its fibres will be found to follow the long axis of the skin wound, though the intercolumnar fibres will be seen and also the interlacing fibres of the intercolumnar ligament. The aponeurosis is not of uniform thick-

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ness, and one or more narrow thinner areas, between strong bundles of longitudinal fibres, will nearly always be found just above Poupart's ligament to the outer side of the external ring. An incision, from three-quarters of an inch to one inch in length, should be made in the direction of the longitudinal fibres, commencing about a finger's breadth above the centre of Poupart's ligament, and extending downwards and inwards in the direction of the external ring. A thinned part of the aponeurosis should be chosen for the incision, if possible, and, in any case, the aponeurosis should be split in the direction of its fibres, and care should be taken to avoid division of important bundles of intercolumnar or oblique fibres. The lower end of the incision in the aponeurosis will end about half an inch from the margin of the external ring.

(4) *Exposure of the Spermatic Cord.* If the margins of the incision in the external oblique be held apart, the fibres of the internal oblique will be seen curving from Poupart's ligament, downwards and inwards, to join the conjoined tendon. By means of a blunt dissector the aponeurosis is separated from the internal oblique below as far as the external ring, outwards as far as Poupart's ligament, and also to the inner side of the incision; there is no need to separate these structures in an upward direction. The lower border of the internal oblique, just above the external ring, will thus be brought into view. A small hook-shaped retractor is next introduced through the incision in the aponeurosis, and, with its help, the lower border of the muscle is strongly retracted by an assistant towards the upper end of the wound (Fig. 5). If a suitable retractor is not to hand, a small aneurysm needle can be employed quite satisfactorily for this purpose. When the internal oblique is retracted the region of the internal ring is exposed, and the cremaster can be seen extending down from the retracted muscle and covering the spermatic cord. A word of warning is necessary at this stage of the operation. If the hook of the retractor be made to press too deeply, and if it be not introduced quite in the long axis of the inguinal canal, the spermatic cord itself may be displaced inwards, puzzling the operator, and leading to an unnecessary delay, and probably laceration of the

muscle, while it is sought for. This is quite easily avoided, and is, indeed, unlikely to occur if only the possibility of the displacement of the cord be borne in mind. With a pair of toothed dissecting forceps and a blunt dissector, the operator now tears through the cremaster, thus bringing into view the spermatic cord enclosed in the infundibuliform fascia just below the internal abdominal ring (Fig. 6).

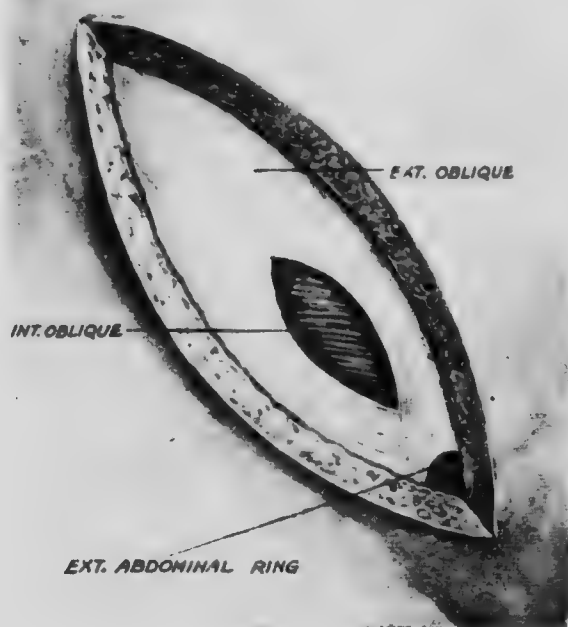


FIG. 5.

(5) *Isolation of the Spermatic Cord.*—The fascial sheath enclosing the spermatic cord and the hernial sac is then seized by dissecting forceps and drawn forwards into the wound. The cremaster is peeled off it, at first in a longitudinal direction and then transversely (Fig. 7). As the cord is gradually freed it is drawn, by traction on the dissecting forceps, more and more through the incision in the aponeurosis until at last it is completely freed behind, when it may be prevented from slipping back into the inguinal canal by passing a pair of Spencer-Wells'

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forceps behind it. When this has been done retraction of the internal oblique is no longer necessary. The entire manipulation should be carried out as gently as possible. The spermatic cord contains the nerve supply of the testicle, and any undue traction may have an effect on the respiration and pulse in this, as well as in other operations for hernia. If the surgeon is careful and the anesthetist watchful, no harm will result to the patient.

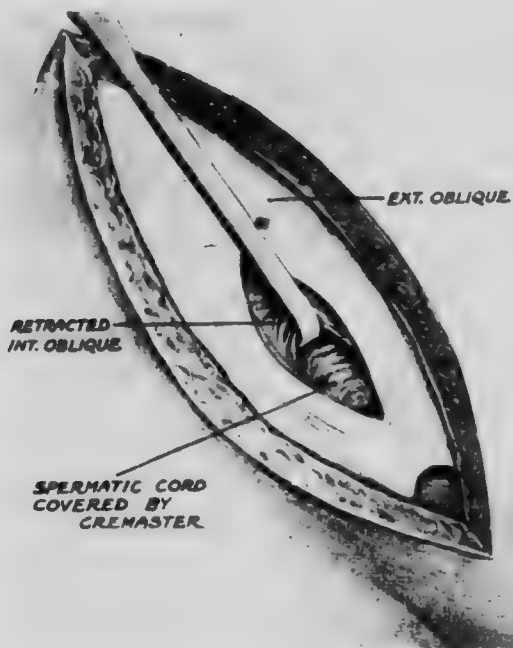


FIG. 6.

This stage of the operation presents no difficulties, and is rapidly and easily accomplished.

(6) *Separation and Isolation of the Sac.*—The fascial covering of the cord is now opened in a longitudinal direction by forceps and blunt dissector. This brings plainly into view the vessels of the spermatic cord, and, as there should be no injury to the veins and hence no bleeding, the white margin of the sac is generally seen at once, and is secured by a pair of Spencer-Wells' forceps (Fig. 8). The longitudinal opening in the fascial sheath

must be of sufficient length, say, three-quarters of an inch, more of the cord being drawn out into the wound if necessary. At this stage of the operation care must be taken not to lacerate the sac itself, under the impression that it is only a fascial layer. This is hardly likely to occur in the type of adult patient we are at present considering, as the sac will probably be a fairly strong, firm and definite structure. Occasionally, however, in adults,

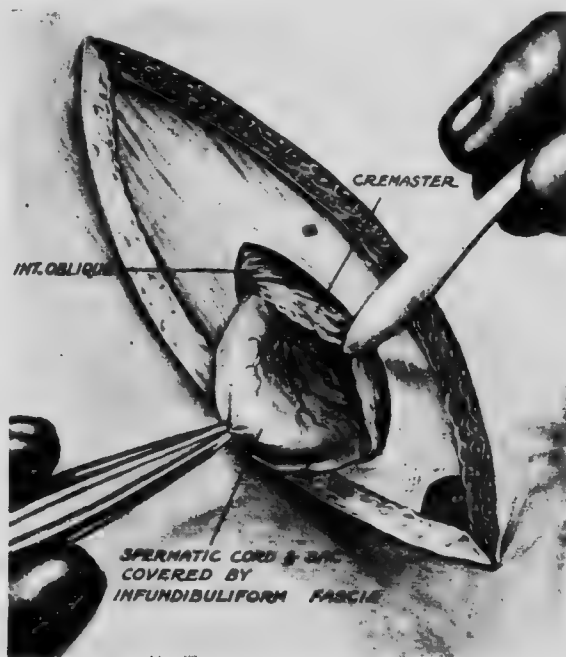


FIG. 7.

and not infrequently in children, the sac may be an extremely thin and delicate structure. Under these circumstances the edge may be transparent and indistinct, and it may then be accidentally opened. This may be recognised by the smooth, shiny appearance of the inner serous lining of the sac, and probably also by the escape of a little clear fluid. In doubtful cases, too, a probe may be passed through the opening into the peritoneal cavity, and also along the distal part of the sac towards the scrotum. Should this accident happen the margins

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of the rent should be secured by a pair of Spencer-Wells' forceps. Provided that it be recognised at once, opening of the sac at this stage is not likely to lead to serious difficulties, but if it should escape notice and the sac be badly torn, the subsequent ligation of the neck of the sac may be a very difficult proceeding.

The edge of the sac having been secured, the next step is to separate it in a transverse direction from the normal structures

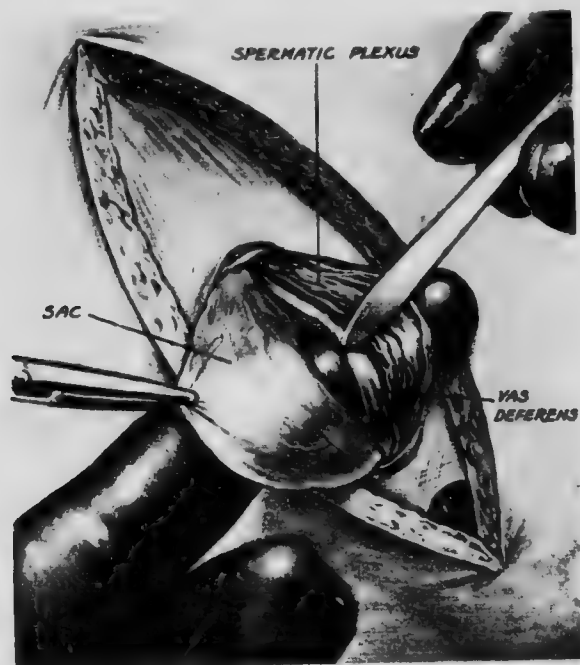


FIG. 8.

of the spermatic cord. A great help at this stage is to keep the various structures well spread out. This may be effected by traction on the edge of the sac on one side and convenient fascial strands on the other, or the left forefinger may be introduced behind the cord and the sac and other constituents be well spread out over this. Transverse separation is effected by gradually peeling away the veins of the spermatic plexus by means of the blunt dissector until the opposite margin of the flattened-out sac is reached (Fig. 8). Isolation and separation

of the sac is usually quite easy; the veins generally peel away without difficulty and without any bleeding, and in many cases the sac can be separated without the vas deferens ever coming into view at all. This structure can be readily recognised by its characteristic appearance and feel, and it is well always, after separation of the sac, to recognise its presence in the cord by these means. Occasionally the freeing of the vas from the sac is a matter of some difficulty. It is often much more closely connected with the sac than are the veins. Indeed, sometimes the vas almost projects into the sac, and when this happens with a thin-walled sac laceration can only be avoided by the exercise of great patience and care. Needless to say, the vas must on no account be seized with the forceps. The parts are well stretched out, and the blunt dissector, working longitudinally, is gradually insinuated through the fascia which connects the two structures. When once the separation has been effected it can be readily extended, both in an upward and a downward direction.

The sac is now completely separated from the accompanying structures for a short distance. The lower end is next pulled upon, and the separation is continued in a downward direction until the lower end of the sac is reached and freed. This is accomplished by the same means, viz., by keeping the constituents of the cord and the sac well spread out, and by the use of the blunt dissector. The lower part of the sac is likely to be more adherent, and sometimes there will be found a solid fibrous cord extending downwards from its lower end, which doubtless represents an obliterated portion of the processus vaginalis. The blunt dissector will suffice even for the separation of this adherent part, and it is as well to avoid the use of any sharp instrument, which may be followed by hemorrhage, whereas, if the blunt instrument is used, any small vessels will be lacerated and will not bleed. Indeed, the whole process of separation ought to be a bloodless proceeding. The lower free end of the sac is now secured by forceps and is drawn downwards while the upper end of the sac is freed by dissecting the vas and the veins away in the same manner. The sac must be strongly pulled upon until the extraperitoneal tissue in the region of the internal

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abdominal ring is distinctly seen and the vas and veins are quite separate from it in this region. The whole sac is now completely free and is ready for removal (Fig. 9). There is no difficulty in separating the lower end of the sac, even if this extends down to the level of the tunica vaginalis, for, by traction, even the upper end of the tunica vaginalis may be drawn up through the external ring, and, if this be of sufficient size, even the testicle may be

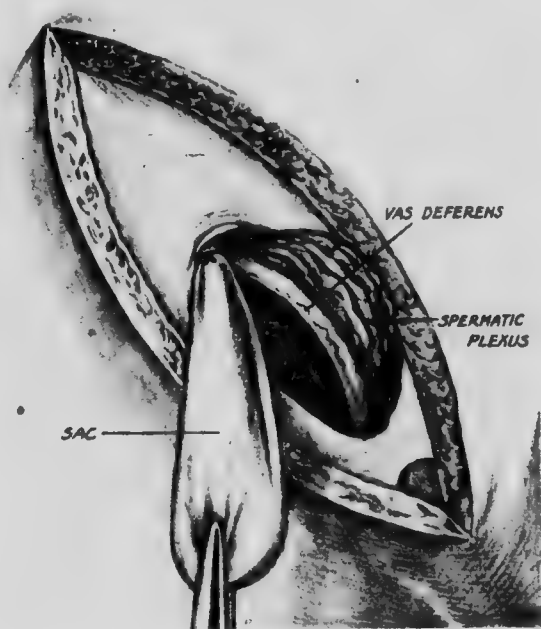


FIG. 9.

brought up into the field of operation. It is of interest to note that in these manipulations the external abdominal ring will never be split open, owing to the action of the intercolumar ligament, though there may be some splitting of the aponeurosis in the opposite direction. It will be well here to repeat that it is necessary during separation that the sac shall be empty. The sac is more difficult to identify, and is much more liable to be lacerated, if it is occupied by a piece of omentum.

(7) *Removal of the Sac.*—If there be any doubt as to whether

a piece of omentum or an intestinal coil occupies the neck, the sac should be opened between two pairs of forceps, and the interior inspected or explored with the finger. The operator having satisfied himself that there are no contents, the sac is drawn down as much as possible, and is then transfixed and ligatured. A piece of medium catgut threaded on an ordinary curved surgical needle serves for this purpose, and the needle is passed through the sac just above the level where the extra-peritoneal tissue is seen. If this is done the sac will be ligatured just above the neck, and is then cut away with scissors. No funnel-shaped projection of the peritoneum into the internal abdominal ring will be left, and the sac will be completely removed. The transfixing ligature is now cut short, and the stump, when released, disappears from view beneath the lower margin of the internal oblique. This muscle now resumes its normal position and covers in the anterior wall of the inguinal canal. The vas and spermatic plexus, with any shreds of fascia, are pushed downwards into the canal with a blunt instrument, and the field of operation now presents much the same appearance as at the beginning of the operation, viz., the incision in the external oblique with the fibres of the internal oblique crossing almost at right angles beneath it. At one time I used to leave the ends of the transfixion ligatures long after removal of the sac, and, afterwards, to thread the ends on a needle separately and pass them through the internal oblique above the internal ring. When tied they fixed the stump of the sac at this level, and hence any dimpling of the peritoneum would be at some little distance from the opening in the fascia. As this procedure must have the effect of fixing the internal oblique at this spot and also of damaging its fibres, I have for some time given it up, believing that the free action of the uninjured muscle is of greater importance than the fixation of the stump away from the internal ring.

(8) *Closure of the Wound.* The small incision in the external oblique is now closed with a continuous suture of fine catgut (Fig. 10), and, after the superficial vessels have been secured by torsion or by ligature, the edges of the skin are brought together by a few silkworm-gut stitches. The extra distance of the lower

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edge of the wound from the groin enables a sterilised pad, secured by a spica bandage, to securely cover the wound without danger of slipping.

(9) *After-treatment.* As a rule, the patient is allowed up at the end of a fortnight, and at the end of another week will be able to walk about fairly well. It is advisable, however, that he should not follow any employment calling for severe muscular



FIG. 10.

exertion for another two or three weeks, and the interval may be employed in exercise involving a gradually increasing use of the muscles. No truss is worn during convalescence, or at any time after the operation.

Treatment of the Sac when this Structure is continuous with the Tunica Vaginalis.

This arrangement of the sac may have been diagnosed before the operation, or the communication may only become evident

when the attempt is made to identify the lower end of the sac (stage 6). There is no difficulty in recognising this condition during the operation, for, as the lower end of the sac is drawn upwards, the upper pole of the testicle can be drawn right up to the external ring, and, if the latter structure is unusually large, the whole organ can be pulled through into the inguinal canal. Two methods of treatment are possible: (a) The sac can be transfixed and ligatured just above the tunica vaginalis, and is then divided on the proximal side of the ligature. In this way the testicle is provided with a closed serous covering. (b) The junction of sac and tunica vaginalis may be cut through and the testicle may be drawn through the opening so that the serous layer of the parietal part of the tunica is in contact with the fascial structures of the scrotum, much as in the operation for hydrocele. Of these methods the first is the most desirable. If the second be adopted, care must be taken that all small vessels in the divided edge of the tunica vaginalis are secured, otherwise oozing may occur with the formation of a hæmatoma of considerable size. In either case the testicle should at once be replaced in the scrotum.

The Operation on the Female.

This is carried out on exactly the same lines. The round ligament is much more difficult to separate from the sac than is the spermatic cord in the male. This is owing to the fact that the sac in the female is much more wrapped round the ligament, and, indeed, the latter is sometimes almost provided with a mesentery. It is thus generally necessary to remove the ligament with the sac, but fortunately this can be done without any after-effects or disability.

The Operation in Adults when Secondary Weakness is Present.

When secondary weakness, as shown by laxity and thinning out of the internal oblique, thinning of the aponeurosis of the external oblique and enlargement of the external ring, is present, provided that the weakness is not excessive and that the age of the patient and the condition of the hernia do not contra-indicate

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it, the following modification of the operation may be tried. It has been pointed out that in such cases the muscles are unlikely to recover their tone and that the weakness must be regarded as permanent. Under these circumstances, suture of the conjoined tendon to Poupart's ligament is unlikely to produce appreciable further weakness, and there is a reasonable prospect that an additional layer of fibrous tissue behind the cord will add to the

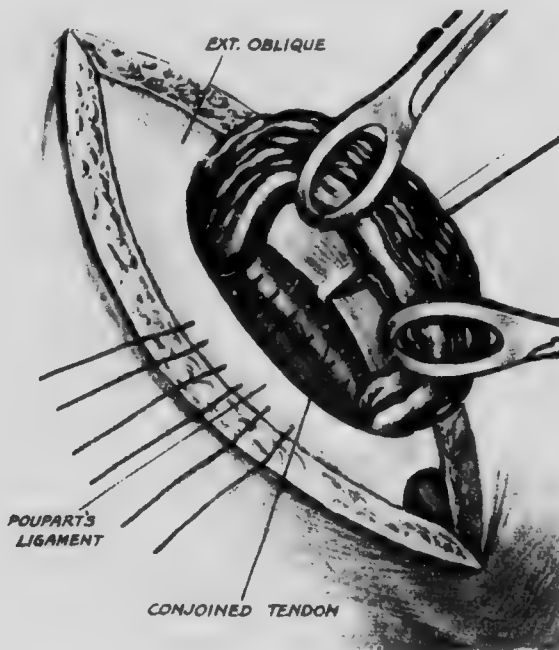


FIG. 11.

strength of this part of the inguinal canal. This, however, may be accomplished without dividing the intercolumar ligament, which, as has been pointed out, is an important safeguard against giving and bulging of the scar and the development of the common form of recurrence after an operation for the cure of hernia. The operation closely follows the lines already described, but the incision in the external oblique is rather longer, and is continued right down to the intercolumar ligament and a little to the outer side of the external abdominal ring. The actual

condition of the internal oblique and the conjoined tendon are now ascertained by inspection and palpation, and it is often as well not to finally decide as to the necessity of suturing the posterior wall of the canal until this has been done. The spermatic cord is exposed, the sac isolated and removed in exactly the manner already described. The spermatic cord, after removal of the sac, is drawn out through the incision in the



FIG. 12.

aponeurosis. Two pairs of Lane's tissue forceps are now made to encircle the whole of the structures which form the cord. These raise and retract the cord at the upper and the lower ends of the wound, and in this way a good view of the posterior wall of the canal is obtained (Fig. 11). The conjoined tendon can be distinctly brought into view, and a little dissection beneath the outer margin will expose the deep aspect of Poupart's ligament. Two or more mattress sutures can now be passed between these structures behind the spermatic cord, and, when

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tied, the conjoined tendon is brought down to the ligament across the posterior wall of the canal. The cord is now replaced, traction being made on the testicle, if necessary, for this purpose.

If the aponeurosis of the external oblique is thinned and stretched, the margins of the incision may be overlapped.

Another method of strengthening a weakened condition of the aponeurosis is the "Darn and Stay-lace Method," independently suggested by Mr. Sampson Handley* and Mr. Charles Bennett.† Though I have no practical experience of this method, it would appear to be of service in these cases.

If the external abdominal ring is abnormally large, the continuous suture closing the opening in the aponeurosis may be continued downwards, approximating the pillars until the ring is of about the normal size (Fig. 12). As the intercolumnar ligament is not divided, this, even if it should do no ultimate good, cannot weaken the ring, and it is possible, if the pillars are thus held together, that the fibres of the intercolumnar ligament may contract or that they may be reinforced by the development of some new fibres. This approximation of the pillars may be carried out in cases where, though the aponeurosis is not thinned and the internal oblique is well developed, yet the external ring appears to be unduly large. It must be remembered that a large external ring alone does not predispose to recurrence, unless there is also weakness of the internal and the external oblique. In any case the ring must not be so diminished in size by the sutures as to cause any constriction of the vessels of the spermatic cord.

Though any operation for the radical cure of hernia is generally straightforward, yet occasionally cases are met with where unexpected difficulties, usually connected with thinness of the sac, intimate connection of this with the vas, or unusual or adherent contents, arise, and call for considerable patience and trouble in overcoming them. In the operations which have been described above, the most important stage is the initial separation of the sac from the spermatic cord. Before and

* W. Sampson Handley, "The Darn and Stay-lace Method for the Radical Cure of Inguinal Hernia," *Practitioner*, June, 1918.

† Charles Bennett, "Inguinal Hernia," *Glasgow Medical Journal*, September, 1917

after this stage, it is unlikely that there will be any particular difficulty, but a little extra time and care expended upon the isolation of the sac from the vas and veins and their fascial connections will save much time and trouble at later stages of the operation. It is of the greatest importance that the sac shall not be lacerated, for, should this happen and the rents extend up to the internal ring, considerable difficulty may be experienced in closing off the peritoneal cavity. Injury to the veins of the cord is easily avoided, but should this occur owing to undue haste or insufficient care, there may be a hematoma causing a long-standing thickening of the cord, and which may lead to an unnecessarily prolonged convalescence. Difficulty with the contents of the sac is not likely to arise, for an irreducible hernia is, generally speaking, a contra-indication to this particular operation. When the separated sac is drawn down preliminary to transfixion and removal, it is as well to carefully inspect the upper end and make sure that the bladder is not drawn down with the neck of the sac. This is very unlikely to happen with the type of hernia for which this operation is indicated, but I have seen it on several occasions. The bladder can be recognised by the presence of muscular fibres. It should be separated from the sac, and care must be taken that it is not pierced by the needle or encircled by the ligature.

Advantages of the Operation.

The sac is completely removed, and, as the ligature is applied above the level of the neck, there is no protrusion of the stump through the internal ring. The operation is simple, easy and neat, and is rapidly performed. With a little practice, it will be found that the time required for the majority of cases is less than a quarter of an hour. The sac is removed with the minimum amount of injury to, or interference with, the structures which form the inguinal canal; indeed, the sac is exposed by drawing the muscles which form its anterior wall aside rather than by dividing them, for the incision in the external oblique does not open the canal, but enables it to be reached by drawing the internal oblique aside. Since the fibres of the internal oblique

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do not run in the same direction as those of the aponeurosis but cross at an angle beneath them, these muscles will, when they subsequently contract, pull in different directions, and hence their action may be compared to that of the abdominal muscles after the "gridiron" incision for appendicectomy. As the sac should be removed without injury to the veins there should be no hematoma, and any subsequent thickening of the cord due to hemorrhage is very unusual. If the inguinal canal be again examined by invaginating the scrotum with the finger during convalescence, it will be found that the external ring has sharp and definite margins, and that both it and the canal show little or no evidence of any injury during the operation. This is very different to the feel of these structures after Bassini's operation, where, owing to the amount of scar formation, it is often impossible to identify the various structures. It is this scar tissue which may yield as the result of continued strain and produce a bulging and "recurrence" in the site of the operation. Another appreciable advantage is that the incision is slightly further from the groin, and hence the possibility of secondary infection of the wound from this region is less. Occasionally, after an operation for hernia, the patient has retention of urine for a day or two, due, I believe, to the extensive dressing which is employed and which often includes scrotum and penis. I have never known retention to occur after this operation, and I attribute this to the simple dressing required and to the fact that it is kept in position by an ordinary spica bandage.

I have heard it urged as a disadvantage that the operation has to be carried out through a "keyhole" incision, which does not admit of a satisfactory view and investigation of the parts concerned. This criticism is scarcely justified, for the only stage of the operation which is carried out through the small incision is the exposure and freeing of the spermatic cord. For the separation, isolation and ligature of the sac the essential part of the operation—as much of the cord as is desired can be drawn out and exposed to view. It is always possible, too, in the event of any unexpected difficulty, to continue the skin incision an inch or two in a downward direction and, by dividing the external ring and opening the canal, to obtain a free view,

and to carry out any other operative procedure which was thought desirable.

Another possible advantage, applying chiefly to cases where there is a slight degree of secondary weakness, was pointed out by Sir G. Makins. It is that, in the event of failure, the inguinal canal would not have suffered any permanent damage. A recurrent hernia is nearly always an unsatisfactory case to operate upon—possibly because, in the majority of cases, some other surgeon has generally performed the original operation—but after the operation described above there would probably be but little scarring, and the parts would be in a favourable condition for some further and more extensive procedure.

In conclusion, it may again be pointed out that the operation is intended for favourable cases in children and healthy young adults and not for large hernias where there is great secondary weakness, or for hernias in middle-aged or elderly people, where the muscles are unlikely to regain strength and tone. There is, of course, every gradation between these groups of cases, and it is especially in these doubtful ones that the modification may be employed.

This method should not be employed for cases of strangulated hernia, for this is essentially an operation for intestinal obstruction, the cure of the hernia being a minor consideration; free exposure of the canal is necessary for the examination and manipulation of the congested and inflamed contents.

For similar reasons, and also on account of liability of laceration of the sac, it should not be employed for incarcerated or irreducible hernias. The importance of making sure that the sac is empty during the operation in ordinary cases has already been insisted upon.

CHAPTER III.

THE RESULTS OF THE OPERATION.

IN the case of children it is generally agreed that, if the sac be completely removed, the results of the operation for the cure of inguinal hernia are extremely satisfactory, even when the neck of the sac is exposed by dividing the external ring and slitting up the aponeurosis of the external oblique. No attempts are made to strengthen the canal, though the aponeurosis and the ring are carefully sutured, and the satisfactory results are attributed solely to the complete removal of the sac. In 1904 Sir H. Stiles, giving an account of a series of 360 cases, wrote : * " As regards recurrence, many of the cases have been too recently operated upon to enable me to give definite statistics. At present I am only aware of a recurrence in four cases. Two were strangulated hernias (both since cured by a second operation), in which the structures at the neck of the sac were freely divided before the bowel was returned. The third was a child with epispadias, in whom there was also separation of the pubes and imperfect development of the muscles of the abdominal wall. The fourth was a delicate infant, aged five months, who developed a slight bubonocoele six months after the operation." Mr. R. W. Murray, in 1909,† records a series of 102 cases without a relapse in at least twelve months after the operation. Many other equally convincing series of cases have been published.‡ The results obtained after complete removal of the sac, after opening up the inguinal canal, are extremely satisfactory, and it might be confidently expected that the results after employing the method described in the previous chapter would be equally good.

* H. Stiles, *Brit. Med. Journ.*, 1904, Vol. II., p. 812.

† R. W. Murray, *Brit. Med. Journ.*, 1909, Vol. I., p. 644, " The After-results of a Series of Operations for Radical Cure of Inguinal Hernia in Children."

‡ Drs. Bullard and Coley, *Med. Rec.*, April 18th, 1905, publish an account of 1,076 operations on children by Bassini's method. There were only six relapses, but mention is made of another series of 125 cases operated upon by other methods, about 1892, in which there were five relapses.

Indeed, I am unaware of a recurrence having taken place in any case in children, say, under the age of sixteen years, in whom I have employed this method. It will, therefore, only be necessary to consider the results in patients who have reached adult life. Between the years 1912 -1915 I operated upon a considerable number of adults, using either this method or the modification, and the results, to the best of my belief, were very satisfactory, though I heard of two or three relapses in subjects of doubtful suitability. The war has been the cause of such an upheaval that it would now be, in all probability, impossible to trace the after-history of any number of these cases. I am, however, by the kindness of the Director-General of the Army Medical Service, able to give some account of a series of cases upon whom I operated in France during the war.

It has already been pointed out that, assuming the truth of the saccular theory, a considerable number of hernias would make their appearance as the result of the change from a more or less sedentary life to the strenuous, active and unaccustomed conditions of military service. This is exactly what did happen, and whereas, in the early days of the war, such cases were invalided home for operation, the number became so large, and the importance of getting the men back to duty quickly became so great, that, unless there was some special indication to the contrary, it was decided that these cases should be treated in hospitals in France.

In March, 1916, instructions were issued to the effect that suitable cases of hernia, varicocele, hydrocele and varicose veins were to be operated upon in certain selected hospitals, one of which was the hospital to which I was attached. These operations were only to be carried out during periods when it was anticipated that there would be no severe pressure upon the accommodation by large numbers of battle casualties. It was further suggested that the cases selected for operation should, as a rule, be men under the age of thirty, and that the hernias should be of small or moderate size, and not of long standing. The instructions to operate only on suitable cases were, however, fairly liberally interpreted, and, provided that the general condition of the patient and the local condition of the inguinal

canal were such as to give a reasonably good prospect of rendering the men quickly fit for general service, operation was advised in men over thirty or with old-standing hernias of considerable size. It will be seen that the careful preliminary examination of the inguinal canal in these doubtful cases was of the greatest importance. Nearly every kind and degree of hernia was seen among those admitted. There were a fair number of recurrent cases, nearly all of which had been operated upon a few months previously in home hospitals, either shortly before, or just after, joining the army. The recurrence was in each case either of the second type, or a combination of both types (*see* pp. 16-17). With one or two exceptions, it was not thought likely that these men would be rapidly fit for full service, and so they were fitted with trusses or invalided home, according to the severity of the condition. In addition to ventral, umbilical, and femoral hernias, there were inguinal hernias of all degrees of severity. Many were middle-aged men from labour battalions who had worn trusses for many years, and who required new trusses in place of old and worn-out appliances. In all, during the year 1916, 147 cases of inguinal hernia were treated by removal of the sac without opening up the inguinal canal, in the manner described in the last chapter. In this series the modification in which the conjoined tendon is stitched to Poupart's ligament was not employed.

Some account of this series of cases would appear to be of interest for two reasons. In the first place, there is the question of the immediate results in a series of operations on "clean" cases in a hospital primarily intended for wounds, most of which, as is well known, were in a highly septic condition. I must admit that I regarded the prospect with some anxiety. A special operating room was set aside for these cases, with separate instruments, dressings and appliances. These operations were not performed when active fighting was in progress, for then the entire accommodation of the hospital was required for wounded men, including the special theatre and instruments. After such a period, before being used for "clean" cases, the operating room was thoroughly cleaned out and all instruments, etc., sterilised before again being set apart for this purpose.

As far as possible separate wards were kept for these patients, but complete separation from wounded men was impracticable, neither was it possible for them to be in charge of a medical officer who had no septic wounds to attend to.

In the second place, considerable interest is attached to the late results of a series of operations for the cure of inguinal hernia, in which the patients are of the fairly uniform type described above; the operation and the conditions of the operation the same in all cases; the after-treatment uniform; and the object of the operation and subsequent treatment the same in all, viz., to render the men fit for full military service in as short a time after the operation as possible. It will be generally agreed that this is a much more severe test than is likely to occur with a number of consecutive cases in civil practice.

As a rule, the operation was performed two or three days after admission, but in a considerable proportion, since most of the men were sent down from duty with their units at the front, often suffering from boils or other septic lesions, slight bronchitis, slight pyrexia, or some other minor ailment, an interval of one or two weeks for the treatment of these disorders was necessary before the men were fit for operation.

Usually, the men were allowed up about fourteen days after the operation, and after another week or so, unless they were kept for a longer period for light ward duty, were discharged to the convalescent depot; there they were given gradually increasing exercises and light duties, and in about three weeks they were sent to their base depots for duty. No case ever had to be re-admitted to hospital from the convalescent depot, and the commanding officer, Lt.-Col. J. Dalrymple, R.A.M.C., informs me that in no case was there any trouble with the wound, and that all the men did well during this stage of their convalescence. Certain of the men were discharged direct from the hospital to their base depots; these were kept at the hospital on "light hospital duty" for three or four weeks instead of spending this time at the convalescent depot. It will thus be seen that the object of the operation was to render the men fit for full duty in about six weeks.

The following table shows the disposal of the 117 cases on their discharge from hospital : —*

DISPOSAL OF CASES.

Total Cases.	To Con. Depot and thence to duty.	Direct to Base Depot.	Invalided to the United Kingdom.
117	117	14	16

As the reason of the operation was to render men fit for service in France, it will be necessary to examine the reason for discharging sixteen cases to home hospitals.

REASON FOR TRANSFER TO HOME HOSPITALS.

- One case (1) . . . Suppuration.
- One case (2) . . . Post-operative thrombosis of the left femoral vein, after an operation for right inguinal hernia.
- One case (3) . . . Severe double coxa vara, discovered only after the operation.
- One case (4) . . . Hematuria and cystitis. Recognised only after operation, but probably pre-existing.
- One case (5) . . . Pneumonia. (Post-operative.)
- Two cases (6, 7) . . . Debility.
- Nine cases (8 - 16) . . . All had been operated upon for some days, and were doing perfectly well. They would all, in the ordinary course, have been discharged to the convalescent depot, but, owing to an urgent order to clear the hospital to make room for wounded, they had to be evacuated.

If the last nine cases be omitted, only seven cases out of 138 had to be evacuated, and of these two (Nos. 3 and 4) were on account of unrecognised pre-operative conditions, and not to post-operative complications.

It will be noticed that only one case had to be sent home on

* Cases of inguinal hernia in which other operations were employed, and cases of femoral and ventral hernia are not included in these figures.

account of suppuration. This was a fairly severe infection, calling for opening up of the wound and one or two incisions for drainage. In addition to this, in a very few, certainly not more than three or four, there was a little trilling superficial sepsis, due probably to a ligature, but scarcely bad enough to delay convalescence. When one remembers the conditions under which the operations were performed, and the fact that probably 50 per cent. of the men were suffering from boils or some other septic lesions at the time of admission, I think that this must be considered very satisfactory.* In all cases the skin was sterilised by means of a 2 per cent. solution of picric acid in methylated spirit, which I had employed instead of the customary iodine solution, since 1913, and which I suggested would be a useful substitute for iodine in military surgery in October, 1914.†

Respiratory troubles after the anaesthetic occurred in a fair number of cases, being generally an exacerbation of some pre-existing condition. Though only one case was evacuated after pneumonia, the two cases described as "debility" were in reality the result of respiratory troubles following the operation.

Late Results.

In 1917 an attempt was made to ascertain the condition of all these patients. At first I intended to ascertain if the result was satisfactory twelve months after the operation, but in those days, in France, twelve months seemed to be a very long time, and the chance of tracing the men after this interval appeared very dubious. It must be remembered that, while these operations were being performed and enquiries were in progress, the first battle of the Somme took place, in 1916, and, in 1917, the battles of Arras, Vimy, Messines and the fighting in Flanders, and that the men sent down for operation belonged to, and were sent back to, units engaged in these struggles.

This being so, and as information was required to guide one

* During the same period there was one other case of suppuration—a varicocoele. Though these operations were continued at intervals until the end of the war, I can only recall two other "clean" cases in which suppuration occurred—another hernia and also a case of varicose veins. This must have been considerably less than 1 per cent. of all cases. The great majority healed firmly and soundly by primary union.

† P. Turner, *Guy's Hosp. Gazette*, October 24th, 1914, "A Note on the Use of Picric Acid for Sterilising the Skin." Also "An Investigation of the Germicidal Properties of Picric Acid," and other papers, *Guy's Hosp. Gazette*, November, 1914.

in future cases of this description, the following plan was eventually decided upon. Six clear months were allowed to elapse after the month in which the man was discharged from hospital. In the month following these six clear months an enquiry was sent out to the medical officer of the unit to which the man belonged before admission to hospital, asking for an examination and a report on the condition of the hernia.

For example, suppose a man was operated upon in April and discharged from hospital in May, six clear months were allowed to elapse, and the enquiry was sent out in the following December. As a matter of fact, in a large number nine clear months intervened between the discharge of the patient and the sending out of the notice. It will be seen that the earliest possible time that the patient could be examined would be over seven months after the operation, and it might be as long as eleven months. Nine months may be taken as the average time. I most thoroughly realise that this time is very short and that the results cannot be regarded as the ultimate results; but the same would be true if the enquiries had been sent out a few months later. We have seen (*see* p. 19) that it is pretty generally agreed that, if a hernia does recur after operation, the relapse usually occurs in the course of a few months, and that from 85-90 per cent. of recurrences appear in the course of the first twelve months. I am inclined to think that, with such a severe test as that to which these men were subjected, the relapse, should it occur, would be still more likely to appear in the early months. At any rate, such a record should enable one to form some idea of the probable ultimate results, and, what was of great importance at the time, give one an idea as to whether it was worth continuing with this particular operation in these cases.

To roughly one-third of the enquiries sent out no reply was received; in roughly another third a reply was received to the effect that the man could not be traced; in some of these the man had not rejoined the same unit, in others he had been transferred to some other unit and had been lost sight of; in others, again, the man had afterwards been again sent to hospital with trench fever, nephritis or some other illness. In the remaining third the men were definitely traced, and a report

received on their condition. Five of the men had been reported as killed, wounded or missing.

The results obtained are shown in the following table :—

Number of cases.	No reply.	Not traced.	Traced.
147	46	50	51
Cases traced.	No recurrence.	Killed or wounded.	Recurrence.
51	45	5	1

If the men who had been reported killed, wounded or missing be regarded as successful cases, as I think is quite justifiable, for they were obviously fit for general service, we have, of the cases that could be traced, fifty fit and only one recurrence in about eight or nine months after the operation. As regards the case which recurred, the medical officer in charge informed me that a swelling reappeared six months after the operation, that he had been provided with a truss, and was able to continue on full duty. It was interesting to note that several medical officers, when writing, pointed out how unsatisfactory it was to have men who were wearing trusses in front line units. It would have been interesting to know to which type the recurrence belonged, but the impression given was that it was a small bulging and probably belonged to the second group.

At first I was rather disappointed that so many of the men could not be traced, but when one remembers the circumstances under which the enquiries must often have been received, it is extremely gratifying that so many medical officers in those strenuous times were able to examine and to report upon the men in question. Large numbers of the men, of course, never rejoined their original units, but had to be sent back to other battalions or units, and many of those who did rejoin were subsequently transferred before the arrival of the enquiry.

Doubtless there were other recurrences among the cases about whom there was no reply, or who could not be traced, and very possibly some of those who were satisfactory at the time of the enquiry relapsed later; but, from the above figures, their number was probably small, and, considering the severity of the test, these results must be regarded as very satisfactory.

These operations were continued during 1917 and 1918, but

in the former year, owing to the urgent need for men, as many as possible were fitted with trusses,* so that those operated upon were of a less suitable type. Though some time may have been saved, it is probable that the slightly longer time required for operative treatment would have made the men much more fit to stand the strain of active military duties.

In 1918, owing to the demands upon hospital accommodation for wounded men, these cases were largely transferred for treatment to special hospitals, where the pressure was not so great.

* Cases suitable for operation were often provided with trusses as a temporary measure. The men were instructed to apply for operation at a later and more suitable time.

CHAPTER IV.

THE IMPERFECTLY DESCENDED AND THE ABNORMALLY DESCENDED TESTIS.

Some Developmental, Anatomical and Pathological Considerations.

THE imperfectly or abnormally descended testicle is a deformity which, though it may not give rise to symptoms during childhood, will almost certainly lead to serious consequences during adult life. The deformity may be unilateral or bilateral, the latter being by far the more serious, on account of the uncertainty as to whether the malposed organs are functional. In either case, however, owing to liability to injury and to attacks of inflammation, it is likely to be the cause of severe disability to a young adult who wishes to lead an ordinary active and vigorous life; on this account it is in ordinary times a bar to those who wish to enter the public services, as well as in many other walks in life. Frequently, too, the deformity is complicated by the presence of a hernia, and in this case the abnormal position of the testicle will have an important bearing upon the treatment of the hernia, operative or otherwise.

The treatment of an undescended testicle is thus a matter of great importance, and I think that it will be generally admitted that the results of the operations commonly employed can scarcely be regarded as satisfactory.

It will be necessary, before discussing the treatment, to briefly consider certain anatomical and pathological points which have a practical bearing upon this. No attempt will be made to go into these matters fully: they will be found adequately described in standard surgical and anatomical text-books and also in Mr. McAdam Eccles' book on the "Imperfectly Descended Testicle,"* to which I am indebted in many of the remarks which follow.

* "The Imperfectly Descended Testicle," by W. McAdam Eccles. London, 1903.

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It is scarcely necessary to mention that the testes are developed during the early months of foetal life, one on each side of the mid-line in the region of the kidney, and that the descent of these organs to the scrotum takes place during the later months, the process being completed before birth. Since, however, imperfect descent must depend upon some abnormality in the natural process, it will be well to briefly consider the manner in which this change in position is brought about.

The spermatogenic tissue of the testicle is developed from the germinal epithelium of the genital ridge, which is situated to the inner side of the Wolffian body. From the latter structure is developed the excretory apparatus of the testicle, including the *coni vasculosi*, the *vasa efferentia*, the *rete testis*, and also the cells lining the basement membrane of the seminiferous tubules. From the Wolffian duct are derived the convoluted tube of the epididymis, the *vas deferens*, the ejaculatory duct and the *vesiculae seminales*. The rudimentary testicle and the Wolffian body soon become suspended from the dorsal region of the peritoneal cavity by a mesentery known as the *mesorchium*. This peritoneal fold is continued in an upward direction to form the *plica vasculosa*, in which the blood-vessels pass to and from the testicle, and in a downward direction, where it is known as the *plica gubernatrix*, because the *gubernaculum* here passes forwards to reach the lower pole of the developing gland.

The *gubernaculum* appears during the fourth month of foetal life, and reaches its maximum development during the sixth month, when it forms a definite cord-like structure extending from the testicle to the groin. It is at first composed of connective tissue, but, later, muscle fibres both of the striped and unstriped varieties are found, the former being derived from the muscular fibres of the developing oblique muscles of the abdominal wall in the region of the inguinal canal. Above it is contained in the *plica gubernatrix*, and is attached to the lower end of the testicle and epididymis; below, its attachment is more complex. It traverses the abdominal wall along the course of the inguinal canal, where part of its fibres blend with the muscles, but the main part of the structure is continued down

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beyond this to the superficial tissues of the groin, where some fibres are attached to that portion of the skin which eventually becomes the scrotum; others are directed inwards, and are attached to the pubis and the root of the penis, while other fibres, again, may be traced to Scarpa's triangle and even to the perineum, where they may be attached to the ramus and the tuberosity of the ischium.

In the sixth month the processus vaginalis makes its appearance. This pouch-like outgrowth of the peritoneum is neither pulled down by the gubernaculum nor pushed down before the advancing testicle, but appears to be a true outgrowth of the peritoneum through the abdominal wall in the situation of the inguinal canal in front of the gubernaculum, deriving, as it extends towards the scrotum, coverings from the internal and external oblique muscles. This gives an explanation of the fully formed processus vaginalis and tunica vaginalis, which are commonly present even when the testicle, owing to the failure of the normal process of descent, may never even have entered the inguinal canal.

There is still a good deal of uncertainty as to the actual mechanism by which the descent of the testicle is brought about, especially as to the part played by the gubernaculum. Probably the principle of "unequal growth," as seen in the marked development of the lumbar region of the spine at this stage of fetal development, has a good deal to do with the change in position; if there is a rapid increased growth of the structures bounding the posterior wall of the abdominal cavity above the level of the primitive testicle, accompanied by a comparatively small increase of the structures below this level, there must naturally be an apparent movement of the testicle towards the lower part of the peritoneal cavity.

The presence of muscular fibres in the gubernaculum suggests that this structure may exert some active influence in drawing the testicle down towards the scrotum, but, on the other hand, the scattered nature of these muscular elements and the presence of cellular tissue has led many to regard it as having a more passive function, viz., that of drawing the testicle towards the scrotum by a slow fibroid change and contraction in the con-

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nective tissue. It is possible that the action of the gubernaculum may be still more passive; it may act simply as a ligament attaching the testicle to the scrotum, so that, as the surrounding parts grow and the ligament does not increase, the testicle gradually assumes a lower and lower position in relation to the abdominal wall and contents. It would seem that the descent of the testicle can be explained by a combination of the two last suppositions without assuming any active contraction of the gubernaculum. In any case, the known attachments of the gubernaculum in the fetus; the relic of this structure, in the normal adult, connecting the testicle with the skin of the scrotum, and its arrangements and attachments in cases of imperfect descent, and especially in malposition or ectopia testis, strongly suggest that it has a very important function in the descent of the testicle from the fetal to the adult position. For the purpose of comparison it may be pointed out that, in the female, the ovary undergoes a similar though less extensive process of descent.

The testicle attains a position opposite the internal abdominal ring in the sixth month, enters and traverses the inguinal canal during the seventh and eighth months, and reaches its permanent position in the scrotum at the end of the eighth month. That part of the peritoneal pouch which occupies the scrotum becomes the tunica vaginalis, while the channel of communication with the peritoneal cavity should rapidly atrophy and close, so that the whole process of descent of the testicles and closure of the processus vaginalis should be complete at birth.

Abnormal Positions of the Testicle.—The testicle may be arrested at any point in its descent between the abdominal cavity and the scrotum. Hence three stages of imperfect descent are recognised: (1) It may be retained within the abdominal cavity so that it cannot be felt on palpation. (2) It may be situated within the inguinal canal. (3) It may traverse the inguinal canal, but be arrested just below the external abdominal ring. In all varieties a certain amount of mobility is generally present. Thus the testicle may be occasionally palpable in the inguinal canal, and, at other times, completely disappear into the abdominal cavity, or, on the other hand,

may sometimes leave the canal below and be felt just below the external ring.

To these three varieties may perhaps be added a fourth, and a less serious. The testicle has reached the scrotum, but hangs at a higher level than normal and is probably decidedly smaller. This condition is often associated with a hernia, and it is while examining the latter that the condition of the testicle is noticed. Attention was drawn to this by Mr. J. G. Culverley,* who points out the desirability of calling the attention of the patient to the condition of the testicle before operating on the hernia, lest the difference in size should be noticed afterwards by the patient, who would then probably attribute it to the operation.

In addition to imperfect descent of the testicle, abnormal descent, or ectopia testis, is occasionally met with. Here the testicle passes through the inguinal canal, but, instead of entering the scrotum, reaches some abnormal situation. Four varieties of this condition are recognised. (1) It may, after leaving the external ring, pass upwards and outwards towards the anterior superior spine of the ilium. (2) It may pass upwards in front of the pubis to the root of the penis. (3) It may pass backwards into the perineum. (4) It may pass downwards and outwards into Scarpa's triangle; it is often stated that, in these cases, the spermatic cord traverses the crural canal instead of the inguinal canal. If it happens at all, this is certainly a very rare occurrence, and, as a rule, the testicle has followed its normal course through the inguinal canal in spite of its abnormal destination.[†]

Many causes have been suggested, both for imperfect descent

* J. G. Culverley, *Lancet*, 1917, Vol. II, p. 277.

† The statement that the testicle may pass through the crural canal instead of the inguinal canal, and reach Scarpa's triangle occurs in many standard works on surgery, including the latest editions of the standard published during the last few years. As a rule no reference is given to the source of the statement, and the case, but if any such is given, it generally turns out, on looking up the original source, to be a clinical example of an abnormal descent of the testicle situated in Scarpa's triangle, in which descent through the crural canal is intimated, but not verified by dissection or operation. For example, Mr. Jacobs, in his book on "The Testis and its Disorders of the Male Organs of Generation," quotes as an example of ectopia testis a case shown by Dr. W. Fowler (*Lancet*, 1890, Vol. I, p. 963). Though the testicle was situated in Scarpa's triangle, there is no evidence that it had descended through the crural canal. The account of the case that the testicle and the spermatic cord had traversed the crural canal instead of the inguinal canal. Mr. McAdam Eccles (*loc. supra cit.*) remarks that the existence of this abnormality is as very doubtful, a statement with which I thoroughly agree. I have never met with such a case and know of no museum preparation which shows it. There is no example in the Royal College of Surgeons' collection.

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and for abnormal descent. It will be best, perhaps, to consider the latter condition first, for here the descent has been satisfactorily accomplished, but, for some reason, the normal position has not been attained; often it will be found that the testicle has actually travelled further than would be necessary for it to reach the scrotum. There is very little doubt that, in most cases of ectopia, the abnormal position of the testicle is due to some abnormality about the attachment of the lower end of the gubernaculum. It has been seen that this structure is normally connected with a number of structures in addition to the skin of the scrotum, and the abnormally descended testicle appears to be drawn into its unusual position by the action of one or more of these groups of fibres. Probably the attachment to the scrotum is weaker than it should be, and the testicle is displaced by the action of the stronger fibres.

For example, in perineal ectopia it is seen that the testicle is drawn beyond the scrotum into the perineum by the action of the fibres of the gubernaculum which pass to this region, and which may be attached to the ischium; presumably this fasciculus is, in these cases, stronger or at any rate has a stronger action than that portion of the gubernaculum which has a scrotal attachment. The abnormal arrangement of the gubernaculum may be verified at operations for ectopia testis.

Another possible cause of the ectopia is that the testis may be displaced to its unusual position by the pressure of a co-existing hernia. This is especially likely when the testicle is displaced either towards the anterior superior spine or into Scarpa's triangle. The occasional association of an interstitial hernia with a displaced testicle strongly suggests that the unusual position and arrangement of the hernial sac is due to some interference with the descent of the hernia by the testicle, and, if this is so, it would seem to be equally possible that in some cases the pressure of the hernia might have an effect in displacing the testis.

The gubernaculum is likewise, in all probability, mainly responsible for the imperfect descent of the testicle, though it is likely that other factors also play a more or less important

part. Weakness of its attachment to the scrotum, deficiency of its muscular action, and attachment to the superficial tissues of the groin in the neighbourhood of the external abdominal ring, have all been suggested as possible causes, and the latter condition is often noticed during operations. It is also very probable, though, so far as I am aware, it has not been verified by actual dissections, that there may be some abnormality about the upper attachment of the gubernaculum to the testicle. Normally it should be connected with the lower end of the testis and epididymis, but should this be weak or absent, and should the gubernaculum end above in the extraperitoneal tissue, or should its main connection be with some other structure, it is manifest that the normal descent of the testicle would be jeopardised. The fact that the imperfectly descended testicle generally shows, also, many signs of arrested development is decidedly in favour of some abnormal process occurring here, and it is conceivable that some error in the formation of the gubernaculum in this situation might, by tension or pressure upon the vessels, interfere with the development as well as with the normal process of descent.

A number of other conditions, among which are the following, have been described or suggested as possible causes of imperfect descent. The long mesorchium, which is generally present, may allow the testicle to hang so freely in the peritoneal cavity that it may fail to enter the inguinal canal, or may only do so at such a late stage that complete descent is impossible. However, the persistence of the mesorchium, as will be explained later, may be due to the absence of the normal pull and guidance of the gubernaculum. Peritoneal adhesions, the result of intrauterine peritonitis, may, in some cases, unduly limit the mobility of the testis; it is, however, very unusual to meet with any traces of these during an operation. Also, shortness of the vas deferens and the veins of the spermatic plexus have been suggested as causes; though these are sometimes found, they are more likely to be the effect than the cause of imperfect descent. The same is probably true with narrowness of the inguinal canal and poor development of the scrotum, both of which have also been regarded as causes. Over-action of the cremaster muscle seems

rather a fanciful cause of imperfect descent,* but it may here be pointed out that, in infants and children, strong action of this muscle may occasionally draw the testicles up to the external ring, or even to a still higher level. This action is only temporary, but it must be remembered that, in a child, absence of the testicle during an examination may be due to this cause; the true condition will be obvious if further observations are made.

The Anatomy of the Imperfectly Descended Testicle.

The examination of pathological preparations and the observations made in the course of operations show that, in many ways, the anatomy of the undescended differs from that of the normally descended testicle. As these anatomical facts have an important bearing upon the operative treatment, it will be necessary to briefly consider them.

The tunica vaginalis is always present, and is often remarkably large and baggy. It commonly extends to a much lower level than the testicle; for instance, it may fully occupy the scrotum while the testis itself is arrested in the inguinal canal. This agrees with the mode of development, for we have seen that the processus vaginalis of the foetus is neither pushed

* Mr. Jacobson, "Dis-eases of the Male Organs of Generation," p. 41, mentions several cases in which a normally descended testicle has been drawn up into the inguinal canal, presumably as the result of a strong action of the cremaster and has then permanently remained in the abnormal position, becoming, clinically, cases of imperfect descent.

I have recently had under my care the following case in which a normally placed testicle appears to have been permanently retracted into the inguinal canal:—D. W., aged nineteen years, was admitted into Guy's Hospital with the following history: In June, 1918, while engaged in his work as a sawyer, he strained himself severely while lifting the trunk of a tree weighing about eight hundredweight; he felt something slip up into his groin, and, on examining himself, found that the left testicle had disappeared from the scrotum. At the same time, or shortly after, a swelling appeared in the left groin. The patient states that until this time both testicles had been present in the scrotum, and that they were of equal size; also that he had never suffered from hernia, and had never had any swelling in the groin. His father and mother both confirmed this history, and were emphatic that nothing abnormal had ever been noticed before the accident. The retracted testicle had never since the accident returned to its normal position. On admission there was a small hernia, and the testicle, which could be felt in the inguinal canal, could be manipulated just through the external ring; the left side of the scrotum was well developed. At the operation the anatomical condition found was that of an imperfectly descended testis; there was a large tunica vaginalis, which connected with the peritoneal cavity by means of a patent processus vaginalis, and the testicle was smaller than the normally placed right testicle.

Here the same strain which drew the testicle up into the inguinal canal appears to have forced some abdominal viscus into the hernial sac for the first time. The pain produced was slight, and on admission to hospital the sensation in the displaced testicle was diminished.

down by the testicle nor pulled down by the gubernaculum, but is an outgrowth of the peritoneum. In practically all cases the processus vaginalis is not obliterated, and hence hernia is a very frequent complication. Not infrequently the hernia occupies the inguinal canal, its further descent to the scrotum being apparently hindered by the presence of the testicle. Even when no hernia can be detected, it is extremely probable that a patent processus vaginalis will be found at the operation. When the testis is abnormally placed in Scarpa's triangle, or is displaced towards the anterior superior spine, the condition of the tunica vaginalis is similar, and there will probably be a co-existing actual or potential hernia. In perineal and penile ectopia, both of which are very rare, a hernia is unusual.

The testicle itself is generally smaller than the normally placed organ when the imperfect descent is unilateral, and smaller than it should be at the age of the patient when the condition is bilateral; it is also softer to the touch. Occasionally it is but little, if any, smaller than the normal organ, but, on the other hand, it may have undergone atrophy to such an extent that it is only the size of a bean or, indeed, it may disappear, leaving no trace except upon histological examination. I met with such a case about a year ago. The patient was a man about twenty-five years of age, with a right inguinal hernia; the right testicle was missing from the scrotum, and, as far as the patient was aware, there had never been any evidence of its existence. There was, however, in the inguinal canal, an ill-defined, slightly tender mass, which was thought to be the missing organ. At the operation no trace of the testicle could be found, even by a finger introduced through the neck of the sac into the peritoneal cavity. A cord-like structure at the upper end of the sac was thought to be the vas, and this could be felt to pass over the brim of the pelvis in the usual manner. On tracing the vas downwards, it gradually got smaller and at last disappeared, without any trace of the testicle being met with. The whole sac, and with it the vas, was removed accordingly. Histological examination of the upper part showed the presence of a normal, but rather small, vas; sections of the lower end showed the presence of a number of tubules in

the wall of the sac, and these apparently represented the rudimentary epididymis. In this case, macroscopically, the testicle had completely disappeared.

The epididymis is also generally small, ill-developed and loosely connected with the body of the testicle.

As a rule, the testicle is attached to the back of its peritoneal sac by a well-developed mesorchium, and, on this account, it may have a considerable amount of mobility. This mesorchium is a persistence of the fetal structure, which is always present at an early stage of development. Its association with an imperfectly descended testis in an adult may possibly be due to failure on the part of the gubernaculum to draw the testicle down behind the peritoneum to its normal position within the tunica vaginalis.

In the normally placed testicle in the adult fibrous remains of the gubernaculum can be recognised, attaching the lower part of the tunica vaginalis and the testicle to the bottom of the scrotum. In the same way, in the imperfectly descended organ, the remains of this structure can be recognised, though its main attachment will probably be to the superficial tissues of the groin or to some other of the insertions already described.

The scrotum may be fully developed, but is often only imperfectly formed. This is especially likely to be the case where the imperfect descent is unilateral. In this case the side of the scrotum which contains the fully descended testis is well developed, but the other side, which has never been occupied, may be so small that the median raphé is more nearly horizontal than vertical.

As might be anticipated, there is generally a good deal of weakness and stretching of the structures which bound the inguinal canal, the result of the presence of the testicle and, very probably, also, of a hernia. This is shown chiefly by the increased size of the internal abdominal ring and a thinning out and laxity of the lower fibres of the internal oblique. The condition of the external oblique and of the external ring will depend largely upon the situation of the testicle and the size of the hernia, but, if the hernia is of fair size, or if the position of the testis varies between the canal and the groin, the ring will

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probably be enlarged and the aponeurosis stretched. Since, however, the patients will nearly always be children or young adults, it may be regarded as probable that the structures involved will recover when the source of weakness has been removed. In those cases where neither testis nor hernia has ever passed through the external ring this potential opening may be small and ill-developed.

Imperfect descent of the testicles is sometimes associated with other deformities due to ill-development. Thus it is likely to be present with ectopia vesicæ, and is occasionally found with epispadias, hypospadias and cleft scrotum (pseudo-hermaphroditism).

Many of the above anatomical points have a practical bearing upon operative attempts to transplant the imperfectly or abnormally descended testicle to the scrotum. It will be well here to enumerate the various structures which may mechanically hinder this proceeding, or which may, after the transplantation has been carried out, tend to draw the testicle back to its former position.

(1) *The Peritoneal Connection of the Testicle.*—It has been pointed out that, in practically all cases of imperfect descent, there is either a hernia or the sac of a potential hernia. The testicle is connected with the upper part of the sac rather than with the tunica vaginalis, and hence, to enable the testis to reach the scrotum, the hernial sac between it and the peritoneal cavity must be removed.

(2) *The Fibrous Remains of the Gubernaculum.*—These must be divided or torn through to efficiently free the testicle.

(3) *Fascial Bands, derived probably from the Infundibuliform or Intercolumnar Fascia.*—These can be cut across or torn through.

(4) *The Cremaster Muscle and Fascia.*—This also can be divided.

(5) *The Undeveloped Condition of the Scrotum.*—In unilateral imperfect descent, though the affected side may be badly developed, the opposite side will probably be well formed. Sometimes, in bilateral cases, the scrotum may be represented only by an area of corrugated skin.

(6) *Imperfect Development of the Inguinal Canal.*—If the

external ring is badly developed, this can be enlarged and stretched. In those rare cases where the whole canal is undeveloped, the testicle will be entirely within the abdominal cavity, and it is unlikely that transplantation will be feasible.

(7) *Undue Shortness of the Spermatic Plexus of Veins.*—This is unusual, and must be distinguished from the presence of the fascial bands which have been mentioned above.

(8) *Undue Shortness of the Vas.*—As a rule, this structure is lax and can usually be drawn down. For it to be so short as to prevent transplantation is rare.

It will be noticed that, of the above, the first six causes can be overcome. The last two are, however, more serious; for any division of the veins or injury to the vas will certainly be followed by atrophy of the testicle.

Physiology of the Imperfectly Descended Testicle.

It is certain that, in the great majority of cases, the imperfectly or abnormally descended testicle is functionless, at any rate as regards spermatogenesis. This is true in those cases where the testicle is of normal size, or but little smaller, as well as in those where it is small, soft and obviously atrophied. Though of comparatively small importance where only one testicle is concerned, it is a serious matter where the condition is bilateral, for, under these circumstances, the patient will probably be completely sterile. But, though the function of spermatogenesis is absent, that of producing the internal secretion necessary for the development of secondary male characters is generally, but not always, normally carried out. That the spermatogenic function is lost is shown by the fact that such persons are unable to beget children, and is also confirmed by the histological examination of retained organs after removal.*

* Mr. L. B. Rawling, *Practitioner*, 1908, Vol. LXXXI., gives an account of a series of cases of imperfectly descended testicle, 50 of which were treated by excision. Of these 27 were examined microscopically, with the following results:

15 cases.	The testicle was atrophic, with increase of fibrous tissue, with imperfect epithelium, and with deficient or absent spermatogenesis.
10 cases.	But little alteration from the normal; definite spermatogenesis present.
1 case.	Tuberculous disease.
1 case.	Malignant.

These figures indicate that the spermatogenic function is not so generally lost as is usually supposed.

The microscopical characters of an undescended testis are thus described by Mr. McAdam Eccles ("The Imperfectly Descended Testis," p. 17): "The seminiferous tubules, or what should be seminiferous, are smaller, more widely separated from one another by the interstitial tissue, and are fewer in number, and probably shorter in length, than those of the normal organ. Between the tubules themselves there is much loose connective tissue, which is rich in blood-vessels, in spite of the otherwise ill-development of the gland. Scattered throughout this tissue there are nuclei, belonging almost certainly to peculiar interstitial stroma cells. In some sections these appear to have undergone considerable development, both in number and size. What their function and significance may be is still problematical. Possibly they are associated with an internal secretion of the organ, a secretion which may be needful for the full development of the male characteristics, and the fact that they are present so uniformly and in proportionately such large numbers in the imperfectly descended testis may point to the fact that they are peculiarly necessary for this purpose in the absence of spermatozoa-producing tubule cells. The basement membrane of the abortive tubules is well developed, but the lumen is filled with a mass of granular *débris*, containing a large number of nuclei of various shapes and sizes, these being probably derived from the cells lining the tubule. Neither spermatoblasts nor spermatozoa can be demonstrated in the tubules of by far the larger number of imperfectly descended testes."

In rare cases the spermatogenic function is not lost, even when there is double imperfect descent with very small testes, or when both organs are arrested within the abdominal cavity; this has been proved, both by the presence of normal tubules and active spermatozoa, on histological examination, and also by the fact that these persons have proved to be capable of procreation.*

The relation between imperfect descent and imperfect

* Many examples of this are recorded in medical literature. There is, however, evidence that those in which spermatogenesis is normally carried out are young men mostly under thirty years of age. In men over this age the imperfectly descended organ is nearly always functionless. In the majority of cases under the age of thirty the spermatogenic function is absent, and the proportion of functional organs is probably small.

anatomical development of the testicle, with absence of its chief function, is a question of great interest, and is still a matter of uncertainty. It may be primarily developmental; that is, from the first, there may be associated with the condition which leads to imperfect descent some abnormality of, or which reacts upon, the germinal epithelium and prevents its normal growth and development. In this case no treatment at any time can restore the spermatogenic function. Or it may be that full growth and functional development are possible, and do take place, up to the time of puberty; at this period, when the final stages should take place, the abnormal situation of the testicle in some way interferes with this and atrophy soon follows.

Another view is that full anatomical and functional development are possible, and may indeed take place, but that certain pathological processes, especially recurrent attacks of inflammation, which are particularly likely to occur in any malposition of the testis, lead to degenerative changes, accompanied by atrophy and loss of function.

Facts may be brought forward and cases quoted in support of each of these views, and it is possible that each of them may, upon occasions, be the actual cause of the loss of the spermatogenic function. In the two last it will be noticed there would be some hope that, if the testicle was transplanted into its normal position at an early stage before degeneration had occurred, the spermatogenic function might not be completely lost.

The important practical point to remember is that the abnormally placed testicle has usually the power of producing its important internal secretion, and that it may occasionally still possess its spermatogenic function. Conservative treatment should, therefore, be preferred to excision, even in unilateral cases, unless atrophy is excessive, and, in bilateral imperfect descent, it is still more important to preserve the organs by transplanting them to the scrotum or, if this is impossible, by returning them to the abdominal cavity.

In children, beyond the deformity, and possibly the presence of a hernia, there may be no symptoms, but in an adult it is extremely likely that there will be pain, which may be so severe

as to completely incapacitate the patient. The pain is due either to injury or to definite attacks of inflammation, which are probably of traumatic origin. The liability to injury depends upon the fact that, in its abnormal position, the testicle is less mobile, and thus is more liable to blows as well as to slighter injuries, the result of friction from the clothes or even of muscular action. The most serious result of injury is the occasional occurrence of torsion of the spermatic cord, which, though a rare contingency, is more likely to occur with an imperfectly descended than a normal testicle, owing, most probably, to the presence of a definite mesorchium and the large tunica vaginalis. Torsion is likely to be followed by gangrene, and will generally call for castration. More frequently there are definite attacks of orchitis, or a chronic inflammation may occur, giving rise to persistent and disabling pain. A common complaint is that, after walking a short distance, severe pain occurs, which renders rest imperative before further exertion can be undertaken. This is probably due to friction with the clothes or to slight injury, owing to the movements of the hip in walking. Inflammation may also be due to any of the causes which lead to orchitis, for instance, after mumps, or to epididymo-orchitis, which is secondary to infection of the prostatic urethra. The most important of these is gonorrhœa, and in the event of septic infection occurring, which is fortunately very rare, the process may, owing to the patent processus vaginalis, extend to the peritoneal cavity. These inflammatory complications are likely to occur when the testicle is arrested in the abdominal cavity, as well as when it is in the inguinal canal or in one of the other abnormal positions. These repeated attacks of inflammation must have an important effect in increasing, even if they do not actually produce, atrophy.

Occasionally a hydrocele may be present, and this may be either of the type of the ordinary vaginal hydrocele or may be secondary to inflammation. The swelling may be reducible or irreducible, though the latter does not necessarily mean that the communication with the peritoneal cavity is closed.

The imperfectly descended testis is liable to be the seat of growths, both innocent and malignant, similar to those which

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may occur in the normally placed organ. Of these the malignant growths are by far the more important. It is often stated that when the descent is arrested the testis is more liable to malignant growths than when it reaches the scrotum. Though specimens are to be found in every museum, this statement is open to question, and, if there is any increased liability to the development of malignant growths, it is certainly not very marked.* Both sarcoma and carcinoma may occur, but the former is the more common; in either case the prognosis is very bad.

Owing to the probable co-existence of a hernia and the liability to the above symptoms and complications, it will be seen that the treatment of cases of undescended and abnormally descended testicle is a matter of great importance, and often of considerable urgency.

* Mr. Russell Howard, in a paper on "Malignant Disease of the Testicle," *Practitioner*, 1907, found that in fifty-seven cases admitted to the London Hospital over a period of twenty years the testicle was abnormally or imperfectly descended in no fewer than nine. These figures are in favour of the view that the imperfectly descended testicle is more liable to malignant disease than the normally placed organ.

CHAPTER V.

THE OPERATIVE TREATMENT OF THE IMPERFECTLY DESCENDED TESTICLE.

THE treatment of the abnormally placed testicle is essentially operative. Palliative treatment may, however, be required in cases where a hernia is present and where it is thought to be advisable to postpone the operation on account of the age of the patient; it will also be called for if operation is refused, or if, for any special reasons, this is considered undesirable. The wearing of a truss is often attended with considerable difficulty. In some cases, where the testicle is below the external ring, the pad of the truss may be arranged so as to support the hernia without pressing on the testicle; in other cases, where the arrest is either abdominal or inguino-abdominal, both hernia and testis may be kept back in the abdominal cavity. Pressure on the testicle by the truss is likely to cause pain, or even severe attacks of orchitis, and this is most likely to occur where the testicle is retained in the inguinal canal; when these complications occur it is impossible for the truss to be worn.

Three methods of operative treatment are possible. (1) The testicle may be transplanted to the scrotum. (2) It may be excised. (3) It may be freed from its attachments and returned to the abdominal cavity. It is often impossible to be certain as to which of these procedures should be adopted until the testicle is seen and its connections examined in the course of the operation; much will depend upon the degree of atrophy present, and the length of the veins and the vas, conditions which cannot be determined by an ordinary clinical examination.* The patient or his relations should, accordingly, always

* It is certainly very unusual for there to be any difficulty in transplanting the testicle to the scrotum, provided that the methods described later are carried out, when the testicle is arrested in, or just below, the inguinal canal. When the testicle cannot be felt, and has never left the abdominal cavity, this difficulty may be met with. I cannot help thinking that in some cases, where the veins are considered to be unduly short, the tense bands which hinder replacement are really fascial bands derived from the sheath of the spermatic cord.

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be informed of this. Though no definite rules can be given, and each case must be treated upon its merits, the following considerations will help in the decision as to the most suitable method of treatment.

Excluding torsion of the cord and malignant disease, both of which will call for removal of the diseased organ, cases of imperfectly or abnormally descended testicle presenting themselves for operation may be divided into two main clinical groups. In the first, the patient seeks treatment on account of the absence or the unusual position of the testicle, or for some symptom, probably pain, to which it gives rise. In the second group, treatment is sought on account of some complication, generally the presence of a hernia or a hydrocele, the testicle itself not giving rise to symptoms, and being regarded by the patient as of minor importance. In either group the trouble may be unilateral or may affect both sides.

In the first group, when the malposition is unilateral and the normally placed organ shows no sign of arrested development, the imperfectly descended testicle should, if possible, be transplanted to the scrotum. If, however, it is small and atrophied, or if some condition, such as shortness of the cord, renders satisfactory transplantation impossible, it should be excised; since the opposite testicle is normal and healthy, there is no need to return the atrophied organ to the abdominal cavity.

When both testicles are imperfectly descended, neither should be excised, on account of the uncertainty of the functional power of either organ. The ideal treatment is transplantation to the scrotum, but should this be found impossible owing to some of the reasons already enumerated, the testis should be freed from its peritoneal connections and returned to the abdomen. Even in this group of cases, where there is no obvious hernia, it is practically certain that a patent processus vaginalis is present, which will allow of this being easily done. When returned to the peritoneal cavity, the testis is less liable to injury and to attacks of inflammation than if it is in the inguinal canal or in the groin just below the external ring, and its functions are just as likely to be performed there as in either of these other abnormal positions.

In the second group of cases, though treatment is especially required for the hernia, the disposal of the testicle is an essential part of the operation. This is carried out upon similar lines to those already indicated. If the condition is unilateral, the hernial sac should be removed, and the testicle then be transplanted to the scrotum; if this is impossible, or if the testis is already atrophied, it should be excised, provided that the position, size and development of the other organ are normal. If a hernia complicated by imperfect descent of the testicle is present on both sides, transplantation to the scrotum is the best treatment, and, failing this, abdominal replacement is indicated.

It will be seen that, in both groups of cases with double imperfect descent, it is a general rule that excision is undesirable, and that abdominal replacement is to be preferred to this.

In cases of double imperfect descent of both groups, it is best to operate first upon one side, and to allow a period of some months to elapse before operating upon the other. The effect of the operation upon the size and condition of the testicle can thus be estimated, and this may have an important bearing upon the second operation. Thus, if the transplanted testis shows signs of further atrophy and degeneration, it is probably best, at the second operation, to replace the other testicle within the abdomen; on the other hand, if the first transplantation is successful, the surgeon will be encouraged to try the same operation upon the second occasion.

It may be said, in unilateral cases, that, as it is extremely likely that the organ is devoid of spermatogenic function, and as the normal testicle of the opposite side is quite functional, both as regards spermatogenesis and the production of the internal secretion, there is no object in preserving a useless structure. It may, however, be pointed out that the question of loss of function is always uncertain, even when the testicle is much smaller than normal, and that it is just possible that a successful transplantation may be followed by further growth and functional development; also, especially if the operation is performed upon a young adult, the patient is generally anxious

to have the organ preserved, if this can possibly be done, quite apart from any question of function. On these grounds conservative treatment should be tried whenever possible, even when the deformity is unilateral.

The next point to consider is the most suitable age at which the operation should be undertaken. It is certainly desirable that the operation should be performed before puberty, for after this date there can be very little hope of further development or return of function. It is also equally advisable that the operation should not be performed at too early an age. One reason for this is that, during the first few years of life, it is still possible that normal descent of the testes to the scrotum may be completed, even though both organs may at first apparently have been arrested within the abdomen. Cases of the descent of apparently retained testicles have been recorded even up to the age of fifteen or sixteen years.

Another reason is that in young children the smallness of the parts, the delicacy of the tissues and the possible ill-development of the scrotum, may seriously tell against the success of the operation. Generally speaking, the most suitable time is between the ages of six and twelve years, the latter being preferable to the former.

It is, however, by no means uncommon to meet with this condition in young adults between the ages of fifteen and thirty years, generally in association with a hernia. In such patients there have usually been few or no symptoms until some change of occupation, generally from a sedentary to an active life, forces them to seek for treatment. Cases of this description were not uncommon among recruits and soldiers on foreign service; when questioned as to why they had not been treated before they generally stated that they had always been like that, and, as it gave no trouble, they did not think that there was any need to have anything done. These cases are treated on the lines already indicated; the testicle is often of fair size, though probably functionless, and transplantation can, in a considerable proportion, be successfully carried out.

The Operation of Orchidopexy, or Transplantation of the Imperfectly Descended Testis to the Scrotum.

There is no need to give a detailed account here of this operation as it is usually performed, for a full description of the methods will be found in the standard text-books of operative surgery. The chief points in the operation are as follows: The hernial sac is first removed, and the testicle and the cord are then drawn down as much as possible. Any bands of fascia or veins which interfere with this are divided, but, in the majority of accounts, the importance of separating or dividing the lower attachment of the gubernaculum to the testicle is only indefinitely referred to or is not mentioned. There is also considerable uncertainty as to the desirability of closing the tunica vaginalis; some accounts definitely advise against this, and suggest that, if the serous surface of the testicle is left in contact with the raw tissues of the scrotum, firm adhesion and fixation are more likely to take place. A bed is then made for the testicle by opening up the cellular tissue of the scrotum. It is generally agreed that simply to place the organ in this is insufficient, owing to the tendency afterwards for it to return to its former position. It is, therefore, usually fixed by one or more sutures passing through the testicular substance and the connective tissue of the scrotum. Even when this is done the tendency of the testicle to resume its former position often causes some immediate invagination of the skin at the site of fixation. This has led to the employment of the following devices to retain the testicle in the scrotum:-

(1) The sutures are passed right through the skin and are tied over a small pad of gauze; the ends are left long and are secured to a band round the patient's thigh, or to a wire framework fitted over the scrotum.

(2) An incision is made at the bottom of the scrotum; the testis is brought through this and is sutured to the skin of the thigh, being, of course, replaced in the scrotum at a later date.

(3) The testicle has been sutured to the normally descended organ of the opposite side.

The above drastic measures are only temporary; they only act so long as the stitches hold, and cease to have any effect as soon as the stitches are removed or when they cut through. The tendency to return to the old position persists for a long time after the operation, and hence a case which, a few weeks after, appears likely to be successful, may, if seen again some months later, show that the testicle has returned to, and become fixed in, the groin. The patient, or his parents, may be instructed to persevere with daily manipulations of the organ in a downward direction, but it appears unlikely that this can entirely overcome the strong tendency to retraction.

In a good many cases the testicle does not develop, but shows evidence of further atrophy, and may become merely a small fibroid nodule; this is generally associated with retraction towards its former position, but may occur even though it remains in the scrotum. This atrophic change is probably due to injury to the testicle and interference with its blood supply. Even a normal testicle is a delicate structure, and in an imperfectly descended and developed organ, which it is hoped will, after transplantation, undergo further development, the injury produced by transfixion and laceration of its substance by sutures, and the interference with its blood supply by tension on the cord, are likely to imperil this desired result.*

Mr. McAdam Eccles ("The Imperfectly Descended Testis," p. 39) thus sums up the results of the operation:

"In a certain proportion of such cases it will grow and develop so as to become in the future a thoroughly efficient organ. The exact number of instances in which this happy termination does occur is unknown, because there are no proper statistics on the subject. But, from the after-inspection of not a few cases where the testis has been transplanted into the scrotum at the same time that a radical operation has been performed upon the accompanying inguinal hernia, it has been found that the

* Mr. L. B. Rawling, "The Surgical Treatment of the Incompletely Descended Testis," *Practitioner*, 1908, Vol. LXXXI., p. 250, investigated the results in a series of forty cases. He classifies them as follows:

4 cases	.	.	.	.	.	Fair results.
3 cases	.	.	.	.	.	Promised favourably.
8 cases	.	.	.	.	.	Not traced.
25 cases	.	.	.	.	.	Failures.

testis has a very great tendency to mount again into the region of the superficial ring, if not actually into the inguinal canal itself, particularly if the case is observed some years after the initial operation. With regard to the second half of the question (that of the possibility of further growth and development), if the testis does remain in position, it will in some instances undergo development; but, on the other hand, should it be retracted, it will as certainly become more atrophied, or, at any rate, not develop. There is here, once more, a significant want of definite record of the subsequent history of these cases, and those that have been traced have not given the operator too much satisfaction."

To sum up, the reasons for the disappointing results of orchidopexy, as performed in the usual way, are as follows:

(1) Injury to the testicular tissues by sutures. There must always be a good deal of tension on these, and this must cause injury and laceration, which will be followed by an inflammatory reaction.

(2) Injury to the veins and interference with the blood supply. Apart from division of any veins, the suture, especially when attached to the thigh or a wire cage, must tightly stretch these vessels and seriously interfere with the circulation.

(3) The lack of any persistent force to counteract the tendency of the testicle to retract after removal of the retaining suture.

(4) Injury to the vas. This structure is very rarely so short as to prevent transplantation. Indeed, it very often forms a loop below the testicle, and may be here injured during the division of its lower attachments. It has also been recommended, when the vas is unduly short, that the epididymis may be dissected away from the testicle with a view to providing additional length, so that the globus minor is uppermost. Such a proceeding is unlikely to be successful, and the injury is likely to lead to atrophy.

(5) Failure to divide the gubernaculum or fascial bands.

(6) An undeveloped condition of the affected side of the scrotum. This is often an important factor, especially in unilateral cases.

For the past few years I have attempted to overcome these

adverse conditions by transplanting the testicle through the septum to the opposite side of the serotum. In unilateral cases the affected side of the serotum is often badly developed, and frequently the median raphé will be found to be directed obliquely or even nearly horizontally. In any case there is always plenty of room for both testicles in one compartment of the serotum.

No stitches are required to hold the testis in its new position: it is prevented from retracting by the smallness of the opening in the septum. The elastic action of the septum, and the weight of the serotum and the normal testicle, supply a slight but



FIG. 13.

continuous force of indefinite duration, which counteracts the tendency to retraction (Fig. 13). The importance of free division of the gubernaculum and fascial bands, extreme care in manipulating the testis, and preservation of the vas and veins has already been insisted upon, and these, together with the enclosure, whenever possible, of the testicle in a tunica vaginalis are all carefully attended to in the course of the operation.

Where both sides are affected, it is possible, in some cases, to operate upon one side, transplanting the testicle to the opposite side of the serotum, and then, after a suitable interval, to repeat the process on the other side, so that the right testicle occupies the left, and the left testicle the right, compartment of the serotum.

**The Operation of Transplantation of the Testicle to
the opposite side of the Scrotum.**

The procedure is exactly the same whether a definite hernia is present or not; in the latter case, there is practically certain to be a potential or unoccupied hernial sac, which will require exactly the same treatment. The early stages follow closely the lines of the operation for the cure of inguinal hernia described in Chapter II. (pp. 22-28), and hence will not require a detailed description.

For convenience, the operation will be described on the right side in a boy aged twelve years, with a testicle arrested in the inguinal canal, but which occasionally presents at the external ring. A similar operation can be performed for most cases of ectopia testis.

The preliminary preparation will be similar to that already described: the pubes should be shaved and both sides of the scrotum prepared, the penis being covered with a roll of sterile gauze or bandage. The operation may be described in the following stages:

(1) **Exposure of the Testicle and Hernial Sac.**

(See Figs. 3-12, Chapter II.)

The skin incision, about three inches in length, runs slightly above and parallel to Poupart's ligament, and ends below, just above the spine of the pubis. The external oblique aponeurosis is exposed by freeing the edges of the incision in the superficial tissues, and the external abdominal ring will be identified in the lower part of the wound. An incision about an inch in length is made in the aponeurosis, in the direction of its fibres, above and to the outer side of the ring, ending some little distance above this, so as not to divide the intercolumnar ligament. The external oblique is now separated from the internal oblique, and the lower border of the latter muscle, which is probably good deal thinned out, is retracted so as to bring the canal into view. This is torn through by means of a blunt dissection, so that the spermatic cord and sac can be exposed, and the infundibuliform fascia, and possibly the gubernaculum, are exposed.

just below the internal abdominal ring. These structures are now seized by dissecting forceps and are drawn forwards, the cremaster being peeled off in a transverse direction until the cord and sac, enclosed in their fascial sheath, are completely freed, and can be displaced from the inguinal canal through the incision in the external oblique. When this has been done a pair of forceps, placed behind the cord, will prevent it slipping



FIG. 11.

back into the canal. Retraction of the lower border of the internal oblique is now no longer required.

2 Separation and Removal of the Hernial Sac.

For the purpose of separating the sac from the spermatic cord, the superficial fascia is carefully torn through in a longitudinal direction for about an inch. This will bring the vessels of the spermatic plexus distinctly into view, and the sac may also be seen at once. Care is taken at this stage to make sure that the sac itself is not torn

open. As soon as the edge of the sac is seen it is secured by a pair of Spencer Wells' forceps; if there is any difficulty in identifying this edge, the left forefinger should be placed beneath the cord and the structures be well spread out over it. When the edge of the sac has been identified and secured the veins and the vas are peeled away, in a transverse direction, with the help of a blunt dissector. A short length of the sac is, in this way, completely separated from the structures which form the cord, and, when this has been accomplished, the blunt dissector, aided by wiping movements with gauze, will readily complete the separation up to the level of the internal abdominal ring. The sac is ligatured in the way and at the level already described (p. 31), and after the sac, a little lower down, has been secured by a pair of Spencer Wells' forceps, it is divided between these and the ligature (Fig. 14). The stump slips up beneath the internal oblique, and the most essential part of the cure of the hernia has been completed.

(3) Closure of the Tunica Vaginalis.

The lower portion of the sac is now separated from the vas and veins until the level of the upper end of the epididymis is reached. It is here again transfixed, ligatured and cut through on the proximal side of the ligature (Fig. 14). In this way that part of the sac between the internal abdominal ring and the epididymis is removed, and the testicle remains enclosed in a peritoneal bag, which forms the tunica vaginalis (Fig. 15). This covering protects the testicle during the manipulations of the later stages of the operation, and also will allow it some degree of mobility when it is transplanted to its new position. Though desirable, this closure of the lower end of the sac is not essential, and if, owing to thinness of the peritoneum, the tunica vaginalis becomes lacerated to such an extent that it cannot be closed, either by transfixion and ligature, or by a simple purse-string suture, it is best to leave it open. Indeed, if a definite hydrocele be present no attempt should be made to reconstruct the tunica vaginalis, but this should be treated as in the operation for the cure of hydrocele.

(4) Division of the Gubernaculum and Fascial Bands.

The lower attachments of the gubernaculum are now put upon the stretch by pulling on the tunica vaginalis and testicle. The strength and extent of these vary a good deal, but, as a rule, they can be torn through, which has the advantage that it is less likely to be followed by bleeding than when knife or scissors have to be employed. After separation, the gubernaculum is

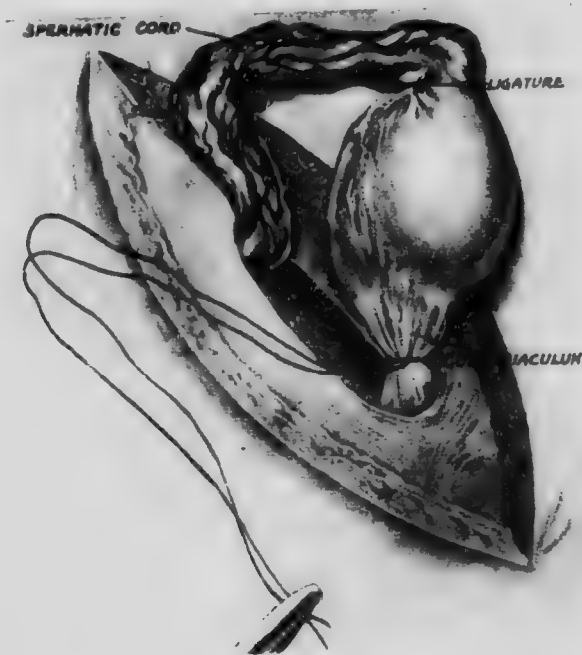


FIG. 15.

transfixed and ligatured by a needle threaded with strong catgut; this, as a rule, should also pass through the lower part of the tunica vaginalis (Fig. 15). The downward prolongation and the size of this structure enable this to be done without fear of injury to the testicle. It is important, however, to remember that the vas often forms a loop which extends in the tunica vaginalis for some distance below the epididymis; this can be detected by inspection and palpation, and, when this is done, it is easy to make sure that it is not included in the ligature.

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This ligature is not cut short, but the extremities of the free ends, each of which should be about six inches in length, are secured by a pair of Spencer Wells forceps (Fig. 16). The cord is next inspected, and any fascial bands remaining from the sheaths of

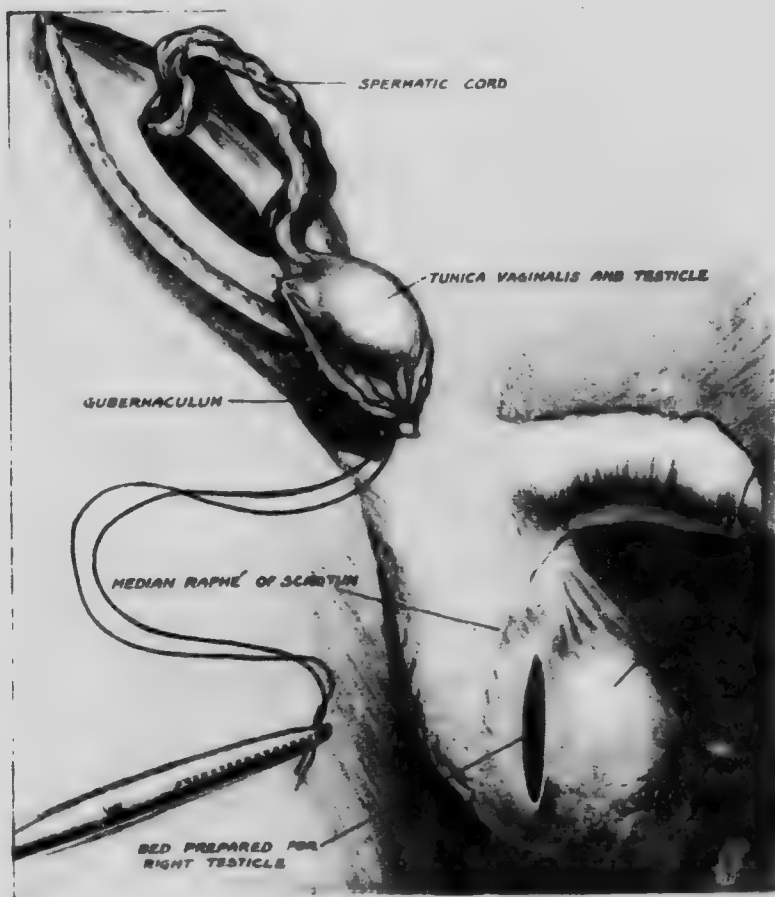


FIG. 16

cremasteric and infundibuliform fasciae, which become tense and prevent the descent of the testis, are torn across or divided. It has already been pointed out that shortness of the veins is an unusual complication, and that insufficient length of the vas is a still rarer condition. When these unusual hindrances to transplantation are present the testicle is usually arrested

within the abdomen, and, in any case, they will have been recognised at an earlier stage in the operation, and the testicle will then be disposed of upon the lines already indicated. The testicle, enclosed in the tunica vaginalis, is now only attached by the vessels and the vas, and it is covered with gauze soaked in hot sterile saline during the next stage of the operation.

(5) Preparation of a Bed for the Testicle in the opposite side of the Scrotum.

An incision, about an inch in length, is made in a vertical direction on the anterior aspect of the opposite side of the scrotum (Fig. 16). Since we are considering an operation for right imperfectly descended testicle, this incision will be on the left side; it is most conveniently made by squeezing the left testicle forwards, so as to make the skin tense. The superficial tissues are divided through the whole length down to the fibrous sheath of the tunica vaginalis, but care must be taken not to injure this structure. When the cellular tissue has been well opened up the margins of the skin incision are retracted by two pairs of tissue forceps, and, after any bleeding vessels have been secured, a space is cleared, either by a blunt dissector or the finger, between the septum of the scrotum and the left tunica vaginalis. The connective tissue is very loose, and an ample bed can readily be prepared; while doing this, there is no danger of opening the tunica vaginalis or of damaging the testis.

(6) Transplanting the Testicle.

The forceps, gripping the ends of the long ligature, are now passed through the incision in the external oblique aponeurosis, and are pushed through the external abdominal ring well down into the scrotum. The closed blades of the forceps are next pressed inwards so as to impinge upon the right side of the septum of the scrotum near its centre, and then, by manipulation of the handle, they are made to present in the scrotal wound, pushing the septum before them (Fig. 17). A small incision is now made with a knife in the septum over the end of the forceps, with the result that the blades, with the ends of the ligature, are

pushed right through into the scrotal wound. When the ends of the ligature have been secured, the forceps are unclipped, and are slowly withdrawn; while this is being done, the blades are opened out so as to stretch open the soft parts and make a



FIG. 17.

channel along which the testicle can pass to its bed on the left side of the scrotum. Though the passage from the inguinal canal to the septum may be freely dilated, care must be taken not to tear open the wound in the septum too widely; it is better to have this rather too small and to enlarge it later if the testis cannot be drawn through it.

The testicle is now replaced in the inguinal canal, and, by steady traction on the free ends of the ligature, aided by pressure from above, it readily passes along the channel made by the forceps as far as the septum. When it arrives here, the pull



FIG. 18.

exerted on the tunica vaginalis makes this assume a somewhat conical shape, the enlarged basal portion of which is formed by the testicle. The narrow pointed portion of the cone, formed by the tunica vaginalis alone, readily passes through the small opening in the septum; steady traction from below, aided by gentle pressure from above, gradually dilates the opening, and



presently the testicle slips through (Fig. 18). As soon as this has happened, the elastic character of the septum causes the opening to contract and thus to prevent any return to the old position. If the opening in the septum should be too small to allow the testicle to pass through, the traction may be relaxed, and a director, guided by the ligature, may be slipped through the opening, which is slightly enlarged by a knife run along the groove. Renewed traction will now draw the testis through into its bed. It will be seen that if the initial opening in the septum be too large, the testicle might partially, or even completely, retract through it. No sutures are required to fix the testicle in its new position; it is simply placed in the prepared bed, which is finally washed out with hot saline solution.

At first there will, in many cases, be a tendency for the septum to be drawn upwards, but retraction to the old position will be resisted by the elasticity of the septum and the weight of the scrotum and normally placed testicle of the left side. This force, though slight, is constantly being exerted, and is of long duration, while fixation by stitches can only act for a few days, until the sutures are removed or cut out. It will be noticed that the channel made for the spermatic cord passes beneath and at some distance from the urethra.

(7) Closure of the Wounds.

The wound in the scrotum is closed by a few silkworm-gut stitches, care being taken that the edges are not inverted. The wound in the groin is closed in the same manner as in the operation for hernia; the incision in the aponeurosis is sutured with fine catgut (Fig. 10, Chapter II.), and this should be continued down to approximate the pillars if the external ring is unduly large. The incision in the superficial tissues is then sutured and the dressing applied.

(8) After-treatment.

This is essentially the same as after the operation for hernia (*see* p. 33). There is, as a rule, little or no pain in the transplanted testicle; orchitis is unlikely, as there has been no suturing or injury of the testis. There may be some induration

and slight tenderness around the testicle and cord. If this persists after the patient gets up, relief may be obtained by the daily application of ung. cetacei. Especially when it has been impossible or undesirable to preserve the tunica vaginalis, and occasionally when this has been done, the testicle may become unduly adherent to surrounding tissues: the application of the ointment also often relieves this condition by rendering the scar more supple, and thus improving the mobility of the transplanted testicle.

(9) Advantages of the Operation.

The chief advantages are that the testicle is not injured by sutures and that there is a permanent obstacle to retraction. The actual transplantation, in the majority of cases, presents no particular difficulties; indeed, these are more likely to occur during the separation of a thin hernial sac and the closure of the tunica vaginalis.

It may again be pointed out that when the testicle is arrested within the abdomen transplantation may be impossible; the condition should then be treated on the lines already indicated. If the imperfect descent is bilateral, the other side may be operated upon after an interval of some months, when the result of the first operation will have an important bearing upon the procedure to be adopted at the second. (*See cases described on pp. 85—88.*)

The Results of the Operation.

It must be admitted that, in a certain proportion of the cases, the local condition does not allow of anything like a perfect result: too much must not be expected from the operation, either by the surgeon or the patient. In an ideal result of an operation for imperfectly descended testicle the following conditions would be fulfilled: (1) The testicle should remain in its new position in the scrotum. (2) All complications should be cured and all symptoms relieved. (3) It should either develop, or regain, its normal functions.

With regard to the first of these conditions, although, owing to the war, I have not been able to keep my cases under pro-

longed observation. I have no hesitation in saying that, in the great majority of cases in which transplantation to the opposite side has been carried out, the testicle does remain in the scrotum, and that the results in this respect are greatly superior to those of the ordinary operation of orchidopexy.

The results may be divided into three groups. In the first, the testicle, though smaller than normal, remains mobile and non-adherent, and, in the most favourable of these, after a few weeks or months, it may be difficult to realise that any operation has been performed. In the second group, the testicle remains in the scrotum, but is at a higher level than normal, and is more or less adherent. In the third group, the testicle appears to have retracted to the original side, and remains there in the upper part of the scrotum. The scrotal septum is a variable structure, which is occasionally weak or incomplete, and it may be that, in the latter group, the tendency to retraction overcomes the resistance of a weak or imperfect cellular membrane.

The relative frequency of the very favourable results of the first group cannot be definitely stated, but, as will be seen from the cases recorded below, in twelve consecutive cases, three—the only ones that could be traced four years after the operation—belonged to this group. In addition, two others of this series were perfectly satisfactory from four to six months after the operation, and of the remaining seven the majority were doing well when last seen. It seems reasonable, therefore, to hope for possibly 50 per cent. of complete successes. Most of the remaining cases will belong to the second group. The third group of results is not often met with, and I know of no case where the testicle has retracted to anything like its former position, or has undergone further atrophy. In the last group, the original position of the testicle before operation was probably abdominal or abdomino-inguinal. It is, however, often possible, even when the descent of the testicle has been arrested in this unfavourable position, for the satisfactory results of the first or second groups to be obtained.

As regards complications and symptoms, it may be confidently stated that any complication, such as hernia or hydrocele, will be cured. Though some slight tenderness may

persist for some time, it is unusual for there to be any severe pain, and a gradual diminution and disappearance, both of pain and tenderness, may be expected.* These symptoms depend upon the position of the testicle, being slightly marked or absent in the first group, and tending to persist for a longer time in the second and, especially, the third. I have never been called upon to remove a testicle which has been transplanted in this way.

With reference to the third point, the return of function, nothing can be added to what has already been said. I have certainly noticed some increase in size in several cases, but this, of course, does not by any means necessarily mean a functional development.

In November, 1914, I showed, before the Section of the Royal Society of Medicine for the Study of Disease in Children, two cases† on whom I had operated some months previously. The first case was a boy, aged twelve years, with double inguinal hernia; both testicles were arrested in the inguinal canals, and neither had ever descended through the external ring. The right testicle was transplanted to the left side of the scrotum in May, 1914, and the left testicle to the right side in July, 1914. When shown, both testicles were present in the scrotum; there was no recurrence of the hernia and no pain.

The second case was a boy, aged fourteen years, also with double inguinal hernia and arrest of both testicles in the inguinal canals. The right testicle was transplanted to the left side of the scrotum in April, 1914. When shown, the testis was of fair size, and was hanging freely and easily in the scrotum: there had been no tendency for it to return to its former position.

I have recently (March, 1919) endeavoured to ascertain the late results of a series of twelve cases operated upon in Guy's

* There is, as a rule, little or no pain after the operation, and convalescence is rapid and uncomplicated. I operated upon several of these cases at a general hospital in France, and, though there had been disabling pain before the operation, the men were discharged to convalescent camps and thence to duty in the same way as the cases of hernia already described. Two of these cases, which had been operated upon for unilateral imperfect descent complicated by hernia, were shown before the local medical society, the result in each being very satisfactory.

† *Proc. Roy. Soc. Med., Section for Study of Disease in Children*, December, 1914, Vol. VIII., p. 17.

Hospital during 1914. The following are the only cases which could be traced :—*

(1) David E., aged nine years, was admitted to hospital in July, 1914, with imperfect descent of both testicles and double inguinal hernia. Both testicles could be felt in the inguinal canals, but neither could be pressed down through the external ring; the scrotum was small and poorly developed. No history could be obtained of the testicles ever having emerged from the canals. The left testicle was transplanted to the right side of the scrotum. The patient was re-admitted in December, 1914, and, as the result of the first operation was satisfactory, the right testicle was transplanted to the left side of the scrotum.

When seen in March, 1919, both the testicles and the scrotum appeared to be perfectly normal, and it was difficult to realise that any operation had been performed. The testicles were hanging normally in a well-developed scrotum, and were not adherent to the scar or to surrounding tissues. They were normal in size, contour and consistency, and there was no thickening either around them or along the spermatic cords.

Testicular sensation was lost on the right side (in the original left testicle), but was present, though probably diminished, on the left side. There was no recurrence of the hernias, and the scars of the scrotal incisions were scarcely visible. In this case the testicles had certainly increased in size, and the development of the scrotum was remarkable.

(2) George O., aged thirty-nine years, was admitted to hospital in August, 1914, for a painful lump in the left iliac region, and vomiting. There was a left inguinal hernia and an undescended testicle in the inguinal canal. The patient had met with an accident a few days before admission, and the pain was due to an attack of orchitis; the testicle had never at any time descended through the external abdominal ring. The hernial sac was removed, and the testicle, which was found to be of fair size and development, was accordingly transplanted to the right side of the scrotum through the septum.

* Two of these cases (No. 1 and No. 3) were shown at a meeting of the Section of the Royal Society of Medicine for the Study of Disease in Children in March, 1919 (*Proceedings*, Vol. XII., No. 8).

When seen in March, 1919, both testicles were in the scrotum, which, though well-developed, was certainly smaller than normal. Both testicles were undersized, the left being, if anything, rather the smaller of the two. The left testicle was freely mobile, and was hanging at the same level as the right; there was no induration, thickening or adhesions to deep or superficial structures, and no abnormality could be detected about the spermatic cord. Testicular sensation was present, but somewhat diminished on the left side. Indeed, from examination alone, one would conclude that there were two normal, but rather small, testicles present in a rather small scrotum; it would certainly be impossible to detect from the examination that any transplantation had ever been carried out. There was no recurrence of the hernia, but a small bubonocoele had recently appeared on the right side. The patient is a married man with five children, the last of which was born three years after the operation. There has been no pain since he was discharged from hospital.

(3) Peter F., now aged nine years, was admitted to Guy's Hospital in 1914, when he was five years of age, for left inguinal hernia and imperfectly descended testicle. The testicle was situated in the inguinal canal, and had never descended through the external abdominal ring; though freely movable in the canal, it could not be made, by manipulation, to pass beyond this. At the operation the hernial sac was excised, and the left testicle was transplanted through the septum to the right side of the scrotum. When seen in March, 1919, over four years after the operation, the left testicle was found to be suspended in the scrotum at the same level as the right testicle, and to be freely movable. There was no pain, and the testis was not adherent to the scar or to any surrounding structure, neither was there any thickening or induration along the course of the spermatic cord. The transplanted testicle was, if anything, larger than the normally placed right organ. Owing to the age of the patient, it was difficult to estimate the testicular sensation, but this appeared to be the same on each side.

There was no recurrence of the hernia, and the scrotum appeared to contain two normal testicles; it was difficult to

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realise that any transplantation had been done, though close inspection showed the scar on the anterior aspect of the right half of the scrotum.

Thus, of these twelve consecutive cases, three were most satisfactory over four years after the operation, and, in addition to these, two others, when shown before the Royal Society of Medicine some months after the operation, were then perfectly satisfactory, and gave every prospect of a good final result.

CHAPTER VI.

THE TREATMENT OF VARICOCELE BY EXCISION.

ONE of the advantages of working in military hospitals is that one is able to judge better than in civil hospitals as to the results of certain operations. In civil hospitals patients with minor surgical ailments are usually operated upon and, when well, are discharged, but the operator, unless specially interested in the particular subject, as a rule, hears nothing more of them. In a military hospital, especially abroad during the war, the operation was probably performed with a definite object, viz., to render the man fit for duty in as short a time as possible. Until this object was accomplished the patient continued to occupy a bed, and the result, if unsatisfactory, could not escape the surgeon's notice. Though the result might have been good anatomically, if the symptoms persisted and convalescence was greatly delayed, so that the patient was not rendered fit for full duty, the operation had to be regarded as a partial failure.

The result of the operation for varicocele, as seen in military hospitals, could by no means always be regarded as perfectly satisfactory.* As might be expected, a number of men of the Expeditionary Force were admitted to hospital with varicoceles which, though probably of long duration, had only given rise to symptoms as the result of active service. Not a few were also admitted who had been already operated upon, some little time previously, at hospitals either at home or abroad, and who still complained of pain and disability. Though in some of these the neurotic element was undoubtedly present, yet, in a good

* Mr. E. M. Corner and Mr. C. A. R. Nitch ("The Immediate and Remote Results of the High Operation for Varicocele," *Brit. Med. Journ.*, 1906, Vol. I., p. 191) investigated the results in 100 cases operated upon in St. Thomas's Hospital. They found that the patient's opinion of the result was as follows:—

Pleased and improved	70 per cent.
Unaltered	26 "
Worse	4 "

many, there was definite pain and tenderness associated with the scar and the indurated area beneath it, where the veins had been ligatured and the divided ends of the varicocele tied together.

Though varicocele is of such frequent occurrence, its etiology is but imperfectly known. It is generally agreed that the chief cause is some congenital abnormality or defect of the spermatic vein and the pampiniform plexus, but the nature of this defect, and the reason why it occurs so frequently on the left side and so rarely on the right, are still matters of uncertainty. It is true that there are certain anatomical differences between the left and right spermatic veins and plexuses; the left is longer than the right, owing to the lower position of the left testicle; the left vein joins the left renal vein, whereas the right opens into the inferior vena cava; also, there is usually an anastomotic connection between tributaries of the left spermatic vein and the veins of the pelvic colon which, of course, join the portal system; but these anatomical characters can scarcely be regarded as the actual cause of the varicocele.

It is also known that increased pressure in, or obstruction to the flow of blood through the spermatic vein will cause the veins of the pampiniform plexus to become varicose. This is shown by the well-known fact that a varicocele will develop, even in elderly men, as the result of pressure on the spermatic vein by a malignant growth in the region of the kidney.

Whatever be the actual cause of varicocele, it is certainly often present in boys under the age of twelve years, and in these, and also in many adults, may give rise to no symptoms. It may thus be first found in the course of a systematic medical examination—for instance, when joining one of the services, or the patient's attention may be drawn to it on account of the development of pain of an aching character, often associated with change from a sedentary to a more active life, or to residence in a hot climate.

In addition to these subjective symptoms, it must be remembered that there is often a neurotic element which, in certain cases, may be so marked as to deserve the name of hypochondriasis. The existence of this nervous and mental factor, which has been discussed by Sir Wm. H. Bennett in his

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monograph on varicocele,* explains, in some cases, the persistence of symptoms after operation; its recognition is of importance, for treatment must, in these cases, be directed to the general and mental condition of the patient as well as to the varicocele.

The usual indications for the operation are either to enable the patient to enter one of the services, or, on account of the existence of pain, either continuous and persistent or brought on by excessive exertion, or by riding; and when the symptoms are only imperfectly relieved by wearing a suspensory bandage.

The symptoms of varicocele are largely due to the weight and dragging of the distended veins, and are increased by any condition which increases this distension, especially the low position of the testicle. The importance of these in the production of symptoms is shown by the relief often given by the mechanical support of a suspensory bandage.

The object of the operation should, therefore, be twofold: (a) To remove the dilated plexus of veins, (b) to raise the testicle of the affected side to a higher level and to give it a more efficient support.

The operation of excision of a varicocele is usually performed in the following manner. The spermatic cord is exposed through a small incision just below the external abdominal ring; the veins, after division of their fascial covering, are separated from the vas, a few being left with that structure and its artery to allow of a satisfactory blood supply to and from the testicle after the operation. By drawing the cord at first in an upward direction, and then downwards, the dilated pampiniform plexus is separated from the vas and its accompanying vessels as low down as the tunica vaginalis and as high as is thought desirable. When ligatures have been securely tied above and below after transfixion of the mass of veins, the varicocele between the ligatures is cut away, and then, with a view to permanently shortening the spermatic cord and raising the position of the testicle, the ends of the ligatures, which have been left long, are knotted together, approximating the divided stumps of the veins.

* "On Varicocele: a Practical Treatise," by Sir Wm. H. Bennett, 1893.

Sir Wm. H. Bennett recommends a somewhat different procedure. The cord is exposed through a similar incision, and, without opening the sheath, the varicocele is drawn forwards and the vas is pressed backwards. The veins, with the sheath, is then ligatured a short distance above the testis. The veins and sheath are now separated in an upward direction for a sufficient distance, and a second ligature is passed round the freed veins a short distance below the external abdominal ring. When this has been tied the intervening mass of veins is removed, and the stumps are brought together by knotting the ends of the upper ligature to those of the lower.

The operation, as usually performed, certainly fulfils the first of the above-mentioned conditions, but it fails to satisfactorily carry out the second. It will be noticed that, after the operation, the testicle is suspended by the joined stumps of the varicocele, and that, owing to the shortening thus produced, its position in the scrotum is raised. The normal testicle, however, is not suspended by the spermatic cord or by the pampiniform plexus; neither does its position in the scrotum depend upon the length of the cord. Both the position and suspension normally depend upon the sheath of the cord, which is composed of a layer containing muscular fibres—the cremasteric fascia, and fibrous layers derived from the intercolumar and infundibuliform fasciæ. All these components of the sheath have definite attachments above, and are continued below around the parietal part of the tunica vaginalis, thus suspending and supporting the testicle. The important part played by the sheath in providing support and, at the same time, allowing free mobility, is shown by the action of the cremaster muscle.

The following sequelæ may be the result of the unnatural support given to the testicle by tying together the divided stumps of the veins after excision of a varicocele:—

(1) There is always a “callus-like” thickening, sometimes of considerable size, at the junction of the divided ends of the varicocele. This is often painful and tender, and these symptoms may persist for a long time.

(2) This inflammatory mass, which is formed around the divided veins, may become adherent to, and incorporated with,

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the surrounding tissues, impairing the free mobility of the testicle. The cord may even become fixed to the scar in the skin of the scrotum.

(3) The amount of inflammation may be excessive and suppuration may occur; this will continue until the ligatures joining the ends of the veins come away or are removed.

(4) Generally speaking, the length of the venous plexus which should be excised is greater than the elevation of the testicle

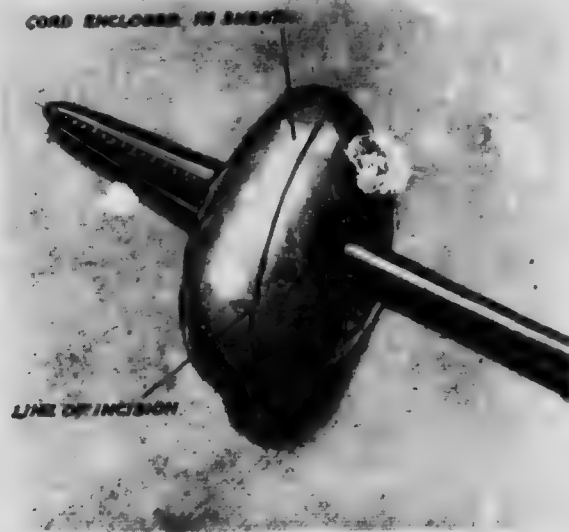


FIG. 19.

which is called for. Thus it may be desirable to remove three or four inches of the veins, while the testicle should be raised, perhaps, an inch and a half or two inches. In some cases the testicle may be unduly raised and at the same time its mobility is impaired. In these cases the testicle is liable to repeated slight injuries by muscular action and by friction from the clothes; pain and tenderness will then persist for a very long time.

Recently, I have endeavoured to overcome these disadvantages by excising the varicocele without joining the divided ends of the veins, and by providing increased support to the testicle

and raising it to a higher level by shortening the fascial sheath. This operation was described in the *Lancet*, 1917, Vol. I., p. 759, and the following account is founded upon that description :

Exposure of the Spermatic Cord.

The spermatic cord is exposed by a short incision, about an inch in length, just below the external abdominal ring. When superficial bleeding vessels have been secured, the cord, enclosed in its fascial coverings, is raised from its bed, freed and drawn

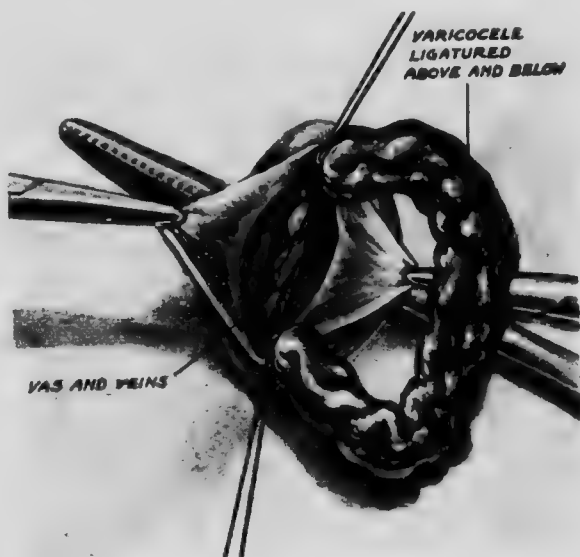


FIG. 20.

out of the wound until the upper end of the tunica vaginalis is brought into view.

Incision of the Sheath and Separation of the Varicocele.

With a knife, or a sharp pair of scissors, an incision, an inch and a half or so in length is made through all the fascial coverings in the mid-line in front until the veins are exposed (Fig. 19). The middle of the incision through the sheath is secured on each side by a pair of Spencer-Wells' forceps, which act as retractors. With a blunt dissector the veins are separated on each side until the vas, which, with its artery and

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some connective tissue, is situated behind and is much more closely connected with the sheath, is reached. The anterior three-fourths or so of the venous plexus, including all the dilated veins, are then separated, leaving a few small veins with the vas, which is not touched and is not separated from the sheath. The anterior mass of dilated veins is now drawn downwards and, by a little dissection, freed from the sheath and the vas as high as is thought desirable. Next, they are drawn upwards, and the

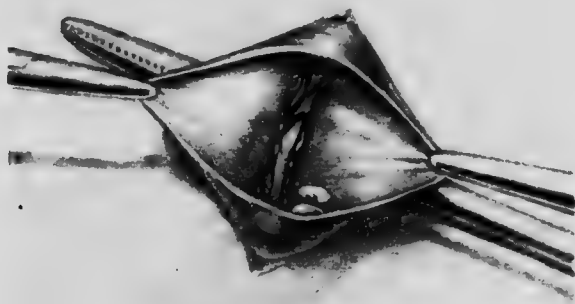


FIG. 21.

same separation can now be effected as low as the upper limit of the tunica vaginalis, care being taken not to open this structure.

Excision of the Varicocele.

The isolated group of veins, perhaps four inches in length, or even longer, is now ligatured above and below by medium catgut, and the intervening part is cut away (Fig. 20). The ends of both ligatures are cut short, and the testicle, which has probably been drawn up into the wound, is replaced in its bed in the scrotum. During the separation and excision of the varicocele there should be no injury to the vessels, but if there

are any oozing points, these are secured. The Spencer-Wells' forceps gripping the edges of the incision in the sheath are now retracted, and the opening in the sheath thus becomes diamond-shaped (Fig. 21).

Suture of the Sheath and Closure of the Wound.

This incision, originally longitudinal in direction, is sewn up transversely, so that the sheath is completely closed and covers over both the stumps of the veins and the vas (Fig. 22). A

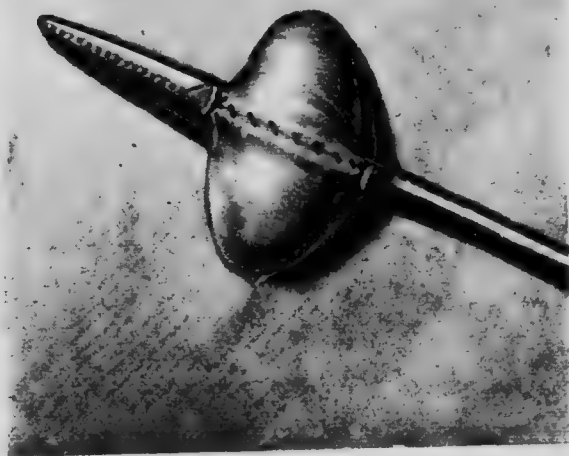


FIG. 22.

continuous suture of fine catgut is most suitable for this purpose, and, in order to avoid any lateral projections, the side angles produced by traction on the forceps may be transfixed at the commencement and termination of the suture and the small redundant portion cut away.

It will be observed that, the longer the original incision the greater will be the shortening of the sheath and elevation of the testicle when the incision is closed. It is therefore desirable to estimate beforehand, from the position of the testicle, the amount of shortening which will be necessary. An incision in

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the sheath, about two inches in length, is required in cases of average severity, but if the testicle hangs very low, this will have to be increased. It is best to excise the veins through a comparatively short incision, and to enlarge this later, if necessary; if a long incision be made at once, the sheath is apt to become ill-defined and to be lacerated during the excision of the veins. The spermatic cord, with its closed and shortened sheath, is now returned to its natural position, and, after the superficial vessels have been secured, the wound is closed by a few silkworm-gut stitches.

Advantages of the Operation and Results.

In the first cases in which I employed this method, I left the ends of the ligatures long and knotted the ends together in the usual manner, completely closing the sheath around the approximated ends of the varicocele afterwards. I came to the conclusion, however, that it was desirable to remove several inches of the varicocele and that, when this was done, tying the ends of the stumps together was unnecessary and might even be harmful. Reconstruction and closure of the sheath, so as to prevent adhesions between the cord and the superficial tissues, is the essential part of the operation. The spermatic artery is, as a rule, removed with the dilated veins, which, as Sir Wm. H. Bennett has shown, is of importance in diminishing the pressure of blood going to the testis at the time when almost all the returning veins are suddenly obliterated.

The artery of the vas is uninjured and the nutrition of the testicle is not affected. It is chiefly on account of the close connection of the vas with the posterior part of the sheath that it is not advisable to attempt to remove a complete section of the sheath and to suture the two ends together; an attempt to do this might result in injury to this vessel or even to the vas itself. The vas is not disturbed during the operation and runs no risk of injury.

As the result of the closure of the sheath, the tender inflammatory nodule is either absent or but very slightly marked, while the testicle remains suspended in the scrotum in a normal manner with its mobility unimpaired.

I have performed this operation in a number of cases, nearly all of which were soldiers on foreign service. Convalescence was more rapid, and there was less pain and post-operative trouble than with the usual method of treatment.

I have not been able to trace these patients, and so am unable to describe the ultimate results, but the condition on discharge was so satisfactory that I do not think that they can have been, at all events, less satisfactory than after the ordinary operation.

With a little practice, the operation thus performed is just as simple and easy as the usual method, and it has the advantage of being much neater.

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